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Vol. II **December, 1925** **No. 12**

CONTENTS

	Page
Frontispiece	1094
Editor's Outlook	1095
The Prize Essay Contest of 1924–25. H. E. Howe, *et al*	1099
Prize Winning Essays, 1924–25:	
The Relation of Chemistry to Health and Disease. Shirley Cordill	1101
The Relation of Chemistry to the Enrichment of Life. H. S. Singletary, Jr.	1106
The Relation of Chemistry to Agriculture. Ruth Jamieson	1111
The Relation of Chemistry to National Defense. Roger S. Makepeace	1115
The Relation of Chemistry to the Home. Marion Honke	1121
The Relation of Chemistry to the Development of the Iron and Steel Industry of the United States. Jane Summers	1125
The Modern Soap Industry (Part II). Walter C. Preston	1130
The Life and Chemical Services of Fredrick Accum (Concluded.) C. A. Browne	1140
Court of Chemical Achievement, Tenth Exposition of Chemical Industries:	
Proteins from Beef Blood. American Protein Corporation	1150
Electrolytic White Lead, Zinc Recovery. Anaconda Copper Mining Co.	1151
Bakelite. Bakelite Corporation	1153
Optical Glass. Bausch & Lomb Optical Co.	1155
Permalloy. Bell Telephone Laboratories	1157
Pyrex. Corning Glass Works	1158
Crodon: The New Chrome Alloy Plate. Chemical Treatment Co.	1160
Duco, Oval Shotgun Powder, Low-freezing Dynamite, Rubber Accelerators, Dyes. E. I. du Pont de Nemours & Company, Inc.	1161
Some Recent Accomplishments of the Chemical Warfare Service	1163
Synthetic Organic Chemicals. Eastman Kodak Co.	1167
Metallic Tantalum. Fansteel Products Co., Inc.	1168
Heat-Enduring Alloy Resisting the Action of Alkali Compounds under Oxidizing Conditions at 2150°F. Victor Hybinette	1170
Karolith—The American Casein Plastic. Karolith Corporation	1171
Isotopes of Chlorine and Mercury and Apparatus for Their Production. New Elements Produced from Chlorine and from Mercury. Kent Chemical Laboratory	1173
Furfural. The Miner Laboratories	1175
Latex Sprayed Rubber. United States Rubber Co.	1176
Catalytic Oxidation of Benzene to Maleic Acid. Weiss & Downe	1178
Chemical Achievements of the U. S. Department of Agriculture	1180
How We Teach Freshman College Chemistry. B. C. Hendricks	1187
Correspondence	1192
Class-Room Emanations	1196
Chemical Digest:	
The Proper Training for Graduate Students Preparing for Professorships in the Smaller Colleges	1197
Abstracts	1199
Photosynthesis of Naturally Occurring Compounds; The Mineral Elements in Animal Nutrition; The Discipline of Chemistry; Discharge of Electricity through Vacuum Tubes; The Making of Soap; June Visits a Glue Factory; Two Engineers and Their Power Plants; Pure Research and Practical Research; Making the Laboratory the Basis of High-School Science; The Character of Laboratory Work for Students of Elementary Chemistry; The Training of Teachers; The Future Science of the Schools; The Transmutation of Uranium into Uranium-X; The Isotopic Composition and the Atomic Weight of Chlorine in Meteorites; Cultural Aspects in Geology; The Russian Academy of Sciences; The Ups and Downs of Nitrogen; Chemistry in and about the Home; Pharmacy Teacher Training; Education for Profit; A New Method of Zinc Coating Wire; Value of the Photograph in Judging Human Character; Chemical Apprentices; The Lecture Method; Nature and Ultranature; H. G. Wells on Education; A Rating Scale for Practical Teachers.	
Local Activities and Opportunities	1205
Recent Books	1210
A Few Moments with the Business Manager	1213
Journal of Chemical Education for 1926	1214
Author Index. Volume II	1215
Subject Index. Volume II	1221

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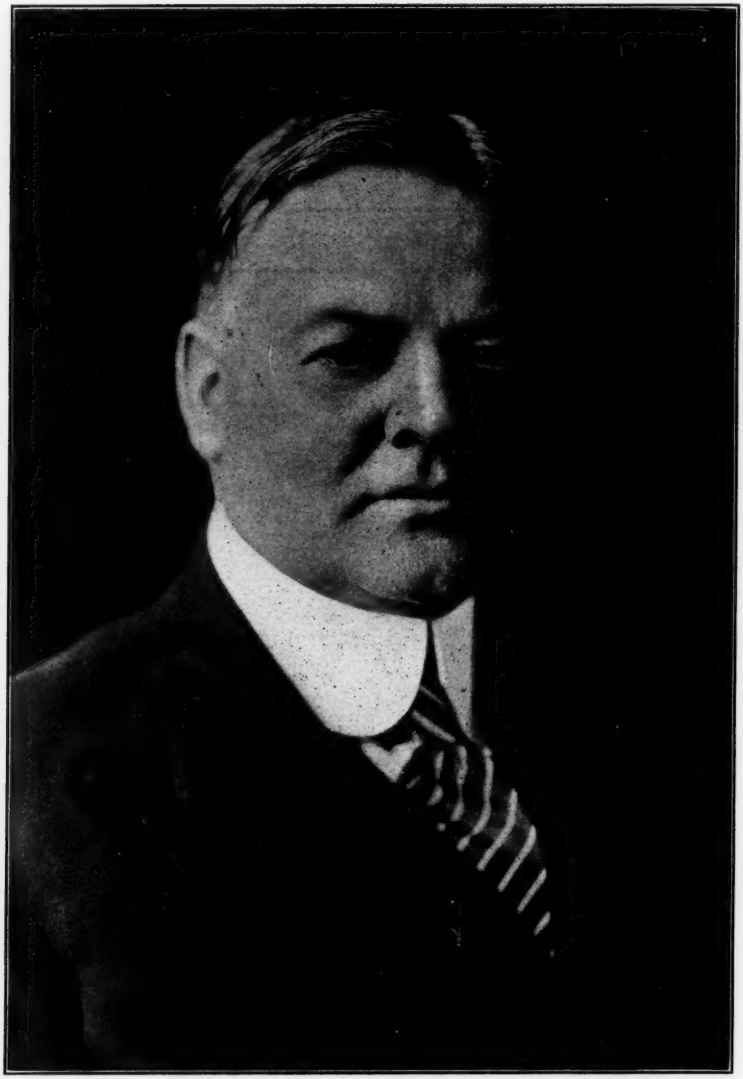

HERBERT HOOVER, CHAIRMAN NATIONAL AWARDS COMMITTEE, THIRD PRIZE ESSAY CONTEST.

EDITOR'S OUTLOOK

Consistency

IN THE November number of THIS JOURNAL, Harold F. Schaeffer[1] voices a plea for consistency or, rather, correctness in the use of chemical terms. We believe that it would not be amiss to extend the reform in nomenclature somewhat farther and eliminate some accepted but misleading usages in favor of exact and rational expressions. The terms, "oxidation" and "reduction" offer an excellent point of departure. The use of a term describing a special case of a general phenomenon to indicate the general process is inevitably confusing to students.

The layman accuses the scientist of concealing his thoughts in a maze of incomprehensible technical verbiage. The scientist justifies his choice of language on the ground of exactness. He must select or, if necessary, invent terms which precisely express his meaning—no more or less. Then he proceeds to his lecture room or his desk and speaks or writes of the "oxidation" of ferrous chloride to ferric chloride by free chlorine. How uneasily Lavoisier and his co-laborers for reform in nomenclature must rest in their graves!

Many text-books are now explaining oxidation and reduction in terms of electrons. At least one, of which we have knowledge, speaks of an oxidized substance as *de-electronized*. Why not revise our nomenclature along with our thinking and speak of *electronation* and *de-electronation* as Cady and Taft suggest in a recent paper?[2] No one discusses combustion in terms of phlogiston. Why speak of electron transfer in terms of oxygen or hydrogen?

The Day of the Specialist

FREQUENT reiteration has impressed upon the minds of most of us the idea that this is an age of specialization. Generally there is the implied or expressed inference that one had best fall in with the spirit of the times if he expects to "get on in the world." Attempts to advise youth often take the form of admonitions to "learn to do some one thing as well as it can be done."

Without digressing to debate the question as to how laudable the ambition to "get on in the world" may or may not be, let us consider just how much specialization contributes toward that end. Is it not almost universally true that the men who are satisfactorily filling positions of responsibility, honor, and profit are distinguished not so much for their ability to do some *one* thing as for their ability to do *a number* of things?

Quite recently an official of a large company, engaged in an industry in which chemistry plays an important part, made the statement that

[1] THIS JOURNAL, **21**, 1059–60 (1925).

there were twenty-three executive positions open in his firm. He said that he could hire chemists by the regiment at a beginning salary of fifteen hundred a year or less, but that almost invariably they turned out to be chemists and nothing else. Similar limitations blocked the advancement of most of the men who entered the organization through the sales force or through the factory. There is little reason to believe that the situation existent in this firm is unique.

The ability to do some one thing well is undeniably an asset—if the emphasis be placed upon "well," where it belongs. Once the emphasis is permitted to shift to "one," we are expressing a limitation rather than a qualification.

Lincoln once made the humorous remark that God must have loved the common people—He made so many of them. By the same token, He must also look upon house-flies, English sparrows, and specialists with particular favor.

When we hear some commencement orator announce that this is the day of the specialist, association of ideas sets in and we say to ourselves, "Every dog has his day. The specialist is having his. Moral: Be a specialist." The association, however, is deceptive. We *should* think of Lincoln and the house-flies. The specialists are having their day only in the sense that there are "so many of them."

Chemistry in Medicine

THE contributions of chemistry to the art of healing constitute one of the most significant and fascinating chapters in the romance of modern science. In this field, especially, it is evident that present achievements scarcely more than suggest the possibilities awaiting future development.

In our own country one of the limiting factors of the rate of progress is the lack of provision for close coöperation between chemists and pharmacologists. Frequently chemists do not know where to turn in order to have new compounds possessing therapeutic properties tested pharmacologically and, similarly, pharmacologists have difficulty in finding chemists able and willing to prepare groups of compounds in which they are interested. The National Research Council is now attempting to fulfill the obvious need for an informational clearing-house.

With this end in view, the Committee on Chemical Research on Medicinal Substances has issued a questionnaire designed to accomplish a threefold purpose:

1. To secure a list of chemists and pharmacologists pursuing investigations in these fields, with a record of the researches they have under way.

[2] "Electronation," read before the 57th annual meeting of the Kansas Academy of Science and reported in *Science*, **62**, 403–4 (1915).

2. To ascertain which of these investigators are interested in the type of co-operation proposed.

3. To learn what institutions have special facilities to offer in these fields, so that prospective students and research workers may be informed.

The Committee "has no thought of attempting to direct or interfere in any way with the research work of anyone, but will endeavor to aid by supplying information likely to be of value and which the recipient can utilize as he thinks best."

This project should meet with a hearty welcome from chemists and pharmacologists alike.

"Selling" Chemistry

THE action of the colored porters at the Pennsylvania Station in New York in establishing a college scholarship to be awarded annually to the son of a porter has called forth considerable editorial comment in the newspapers and popular magazines. We heartily endorse the general sentiment that this is a really wonderful thing and join in the hope that the "Red Caps" shall find just cause for pride and satisfaction in the results of their bargain.

To teachers of chemistry it is particularly interesting to note that the scholarship is to be awarded each year to the son of a station porter who has achieved the highest school record in English, mathematics, history, *and chemistry*. Doubtless the porters reasoned that previous scholastic standing should constitute a reliable indication of inclination and ability to utilize further educational opportunities. Doubtless also they selected, as a basis of comparison, those subjects which they believed most important as factors in education. One would have expected the traditional "three R's" to take first place. Nor is the inclusion of history, long extolled for its cultural value, surprising. Why, however, was chemistry chosen to complete the group of subjects considered?

All of us as chemists can advance many good reasons why the choice was a wise one. Nevertheless we would hardly have expected the porters to form so well-founded an opinion. Our theory is that this is but one of the straws which indicate the trend of popular interest and another evidence of the growing hold of chemistry upon the popular imagination.

We are not surprised when Mr. Hoover consents to act as Chairman of the Prize Essay Awards Committee nor when bankers inquire into the research activities of industrial firms which apply to them for loans. We know these men to be intelligent and well-informed and we take it for granted that men who are both, will recognize the value of science and scientific education. The task of convincing the man in the street, how-

ever, becomes an act of almost pure salesmanship. We believe that the incident mentioned is indicative of the effectiveness with which the popularizers of chemistry are attacking their task.

Exchange Professorship

THE growing practice of American universities in arranging exchange professorships with foreign institutions is one which is worthy of every commendation and which we hope to see rapidly extended. Travel is admittedly an experience affording great cultural and educational possibilities.

Unfortunately most college professors are debarred by lack of means and leisure from taking advantage of the benefits to be derived therefrom. Frequently, when a professor is able to take a long-planned trip, these material considerations react to limit him to a tour which presents all the educational aspects of a ride in a "rubber-neck wagon" and offers just about as much opportunity for cultural development. He is denied the pleasure and mental stimulation arising from social intercourse and mutual exchange of ideas with men of similar interests and abilities in other countries. If he attempts to arrange such visits at all, they are usually of necessity hurried and unsatisfactory affairs. All his impressions are naturally the result of incomplete observation and lack the breadth and sense of proportion which are acquired only after a period of residence.

All these difficulties the exchange professorship can obviate or at least ameliorate if properly administered. The potential benefits are enormous in comparison with the monetary expenditure required.

The student body of a university is, of course, indirectly benefitted by any influence which contributes to the betterment of the faculty. Through the exchange of professorships it also benefits more directly and immediately. America is becoming increasingly independent of foreign nations, educationally as well as materially, in so far as curricula and educational equipment are concerned. There still are, however, and always will be professors in foreign universities whose personalities and accomplishments are such that their courses well repay the necessary expenditure of time and money involved in the pursuit of foreign study—always provided that one has the time and means to expend. The vast majority of American students is not so fortunately situated. Thus the exchange of professorships offers to many students advantages which would never otherwise be open to them and offers those advantages at no additional expense.

THE PRIZE ESSAY CONTEST OF 1924-25

Report of the Prize Essay Committee

The second national Prize Essay Contest under the auspices of the American Chemical Society and made possible by the gifts of Hon. and Mrs. Francis P. Garvan, was held during the academic year of 1924-25. The contest proceeded along substantially the same lines as the first contest, except that it closed earlier in order that the committees might be able to judge essays and if possible announce the awards at high-school commencement time. As a result, with the exception of a few high schools which closed at a very early date, the schools attended by state winners kindly coöperated by presenting the prizes as one of the features of the commencement exercises.

Having noted that contestants had greater difficulty in acquiring reliable information on the relation of chemistry to industry, Volume I of "Chemistry in Industry" was compiled with the aid of twenty-one individual authors, each a specialist in the field of which he wrote. This illustrated volume was distributed on a non-profit basis and the book is now in its thirtieth thousand. Volume II, containing twenty-two chapters, has since been prepared and is now available. The committee continued its work of distributing sets of books and individual volumes and believes that through this activity there is now a far greater appreciation of the relationship of chemistry to everyday life than ever before.

The large number of essays to which the committees in the first contest gave attention showed the desirability of asking the several schools to pass preliminary judgment on the essays written by their students. The committee felt it was only fair to ask this assistance on the part of teachers and principals to the end that their schools might have the best representation possible and that the work of the volunteer committees might be lightened. As a result, 5570 essays were submitted to the state chairmen after preliminary judging, first in the schools and later by the several committees in the states who assisted in selecting the best of the essays for the attention of the state chairmen and their committees. While the committee did not feel it to be necessary again to send out a questionnaire such as that upon which the statistics of the first contest were based, it can nevertheless be stated that more essays were prepared for the second contest than for the first.

The second contest included the extra-territorial possessions of the United States taken as a whole and the committee was greatly pleased with the interest displayed in Hawaii, the Philippines, and Porto Rico. If the high schools in the United States would display as much activity as high schools in our island possessions, it would be most encouraging.

In those schools where the department of English coöperated with the

science department and where some credit was given for essays prepared as a part of regular assignment work, we find teachers enthusiastic over the possibilities of the contest as a means of renewing interest in regular courses and in requiring a greater familiarity with libraries and other sources of information. Some schools now require the preparation of essays as a part of the regular assignment and the best of these are entered in the Prize Essay Contest.

The following information concerning the winners of the first and second contests will be of interest.

Winners of 1923–24 Contest

Elton R. Allison, Graduate of Centralia High School, Centralia, Wash., now in second year at University of Washington.

Eugene Russell Brownscombe, Graduate of Santa Rosa High School, Santa Rosa, Calif., entered Yale, September, 1925.

Benjamin Nassau, Graduate of Hartford Public High School, Hartford, Conn., now in second year at Yale.

Oliver Chandler Pittman was sophomore at Commerce High School, Commerce, Ga., at time of winning award. Will enter Yale in September, 1926.

James Cole Reid, Graduate of Bryan Street High School, Dallas, Texas. Entered Yale, September, 1925.

Donald L. Vivian, Graduate of Phoenix Union High School, Phoenix, Ariz., entered Yale, 1925.

Winners of 1924–25 Contest

Shirley Cordill, Graduate of Isidore Newman Manual Training School, New Orleans, La. Plans to matriculate at Vassar, September, 1926.

Marion Honke, Graduate of St. Angela's Academy, Carroll, Iowa. Entered State University of Iowa, September, 1925.

Ruth Jamieson, Graduate of Whittier Union High School, Whittier, Calif. Entered Whittier College, September, 1925.

Roger S. Makepeace, Graduate of Phillips Academy, Andover, Mass. Entered Yale, September, 1925.

Henry S. Singletary, Jr., will graduate from Port Arthur High School, Port Arthur, Texas, in January, 1926. Will enter Yale September, 1926.

Jane Summers, Graduate of Ensley High School, Ensley, Ala. Entered University of Michigan, September, 1925.

It will be noted that, while originally the contest provided four-year scholarships at Yale or Vassar, together with five hundred dollars annually for four years, where special circumstances made it desirable, the donors of the prizes have accepted the recommendations of the committee that the winners be allowed to continue their education at other approved educational institutions.

The college contest resulted in over five hundred essays being submitted. The topic selected for the second writing was "An Outstanding Contribution of Chemistry to Human Welfare." As a result, the six winners were judged to be Jesse C. Hendricks, Franklin, Indiana; Gilbert H. Ayres, Taylor University, Upland, Indiana; Richard Middleton, University of Utah, Salt Lake City, Utah; Harriet Emigh, Whitman College,

Walla Walla, Washington; Catherine R. Loughrey, State Normal School, Worcester, Mass; T. J. Conrad, Jr., Rutherford College, North Carolina.

The present contest is the second for college and university students and differs from the first in that a second writing will not be required. The essays under each of the six subjects will be judged and the winner announced as promptly as possible.

The fears expressed by students in some of the smaller colleges that they would have no chance in competing with students in the larger universities and that because of facilities the students in one geographical section would be handicapped in comparison with other sections have been shown to be unfounded by the results of the first contest. There is reason to believe that the second contest will be brought more forcibly to the attention of students and that the present contest will result in a great increase of competing essays.

The third high-school contest which is now in progress will close even earlier than the second. It is believed that by concentrating upon the contest for a brief time more satisfactory results will be obtained and that even better coöperation on the part of the schools may be expected.

The committee wishes to take this opportunity to thank sincerely all those who have assisted in making the preceding contest so successful and again to bespeak their continued coöperation in this constructive educational effort.

H. E. HOWE, *Chairman*
W. D. Bancroft
CHAS. H. HERTY.

THE RELATION OF CHEMISTRY TO HEALTH AND DISEASE*

SHIRLEY CORDILL, NEWMAN MANUAL TRAINING SCHOOL, NEW ORLEANS, LA.

Chemistry is the study of the composition and transformation of matter. Upon the transformation of matter, life in all its forms is dependent. Within the body of any living thing, whether it is an animal or a plant, matter is being constantly transformed. With us, every action of our bodies from the breathing of the air and the digestion of our food to the elimination of waste products, involves the transformation of matter. Our bodies are constantly manufacturing and using up chemicals. It is but natural that it should require chemists to study these chemical changes.

For several hundred years chemistry and medicine drifted farther and farther apart, first in the vain attempts of the medieval alchemists to

* Prize-winning Essay (1924–25).

make gold, and later in the more practical form of real industrial advancement. It is only within the last century that we have once more begun to realize the value of chemistry in its relation to medicine.

More and more, physicians are beginning to find that it is to chemical disturbances that most of the bodily ailments are due. Simple indigestion is often due to the fact that the stomach has not the right proportion of pepsin and acid to digest the food thoroughly. Yet the exact parts played by pepsin and acid in the digestion of our food have never been accurately determined. Here, indeed, is one of the many wide fields which lie ready for investigation by the combined forces of chemistry and medicine; for is not a detailed knowledge of the workings of our digestive systems necessary for the complete health of many millions of people?

To properly show the relation of chemistry to medical progress, a brief account of some of chemistry's chief contributions to medicine must be given. The greatest discovery known to medical science, perhaps the greatest discovery of the nineteenth century in any field, was the finding of microbes. This discovery was made by a man trained to be a chemist, Pasteur. The gate of the realm of the infinitesimally small, the causes of disease, was thrown open, and a great domain of possibilities in the discoveries of cures and preventive measures lie before medical science.

Pasteur, as a chemist, first found microbes in his studies on ferments. He found that all fermentation, whether it was of wines, of beer, or of sugar, was caused by small living beings. The minute beings he called microbes, or bacteria.

It is hard to realize the value of the discovery of microbes as living beings. But Pasteur was not satisfied with this discovery. He next set about disproving the theory of spontaneous generation. Pasteur's object was to prove that microbes were born from other microbes of the same family, and that their number under favorable conditions constantly increased. This he held was the secret of the transmission of contagious diseases. To prove his theory, Pasteur and his colleagues performed hundreds of experiments in isolating and killing the germs for various diseases, first in animals and then in people. These men were nearly all chemists but their work has been of great service to medicine.

Pasteur's first work on a disease which directly applied to human beings was in his experiments on rabies. Based on his discovery of microbes, he found a new treatment for rabies and hydrophobia. Rabic virus can be weakened by exposure to the dry air. Patients are inoculated first with virus that has been kept fourteen days, and then each time with a stronger virus, until finally the inoculation is made with virus kept only three days. By this treatment the nerve centers of the patient become so hardened that the bite of a mad dog has no effect on him.

Using similar methods, Pasteur's followers have succeeded in isolating the diphtheria germ. An antitoxin has been made, which when injected into the body stops the effect of the diphtheria germs. The lives that have been saved by this antitoxin are beyond estimate.

Within the twentieth century many serums have been found and many diseases prevented by these same methods. Recently much has been brought to light on the subject of scarlet fever. Dr. George Dick and Dr. Gladys Henry Dick have succeeded in isolating two strains of hemolytic streptococci from the throats of people suffering from scarlet fever. Both of these strains can be made into toxins with which vaccination in increasing amounts can be made. A person can thus be rendered immune from scarlet fever.

The discovery of microbes was of great benefit to mankind in its relation to surgery. Pasteur successfully proved that it was to microbes that infection of wounds was due. He introduced the practice of sterilization of surgical instruments, showing that heat killed all such germs. From this has come our modern use of antiseptics which has saved the lives of countless thousands in the hospital wards.

During the World War a great problem was to find a suitable antiseptic. After months of tireless experimenting, two chemists, Dr. Alexis Carrel, and H. K. Dakin found a solution now famous as the Carrel-Dakin solution, which was strong enough to stop infection after it had once begun but still did not harm the tissues.

Another field in which chemistry has been of great aid to medicine is in the discovery of anesthetics and their uses. Here too, the need for coöperation between chemists and doctors has been clearly shown. Ether was discovered by the chemists in the thirteenth century, but it was not definitely recognized as an anesthetic of great value until 1846. What untold suffering would have been avoided, if in this instance, chemistry and medicine had united! In 1800 Sir Humphry Davy was experimenting with nitrous oxide when he discovered its anesthetic effect on himself after he had inhaled it. He found that it relieved local pain, and suggested that it be used in surgery; but his suggestion was unheeded for almost half a century.

In connection with anesthetics the story of cocaine is of great interest. Cocaine is a drug, a white crystalline substance found by Von Anrep to render certain parts of the body dead to pain. It was introduced into surgery by Koller, and has been an invaluable local anesthetic. But there are several serious objections to the use of cocaine. Chief among these are that it is very rare and that it contains poisons. When it was used the results were often fatal. Then the problem of improving this drug was undertaken by chemists: and, after three attacks by the leading chemists of the day, it was finally solved. The structure of the cocaine

molecule is extremely complicated; it contains forty-three atoms, arranged in an unusually complex manner. It was found that only a certain part of the molecule has the anesthetic effect, the other parts are closely related to the hemlock principle, coniine, and to nicotine. As a result of these researches the chemists were able to make artificial anesthetics which had the anesthetic power of cocaine without the disadvantage of containing poisons. Such products as these are novocaine, procaine, beta-eucaine, apothesine, and benzyl alcohol. The use of these local anesthetics is growing, even to their application in major operations: for these anesthetics may be used without the risk of poisoning the whole system as with ether or chloroform. This field still offers opportunities for great advancement. There are a number of other anesthetics in use today, but there are serious objections to each one. In time, however, chemists ought to, and will, find a perfect anesthetic.

This brief sketch serves well to show the service which chemistry can render to her sister science, medicine.

Remedies have been found by chemists for many diseases, such as syphilis, hookworm, epilepsy, and more recently, even leprosy. These are the results of the coöperation between chemistry and medicine—a coöperation sadly needed, as was shown not only in the case of ether, but in that of other chemicals that are used for medical purposes.

In the seventeenth century chemists were familar with magnesium sulfate, but not until two hundred years later was it found to give great relief to lockjaw, burns, and strychnine poisoning. Chemists discovered amyl nitrite twenty-three years before physicians found what instant and complete relief it gave to that terrible disease of *angina pectoris*. Such tragic delays as these illustrate the necessity for the complete coöperation of doctors and chemists.

Now, however, the chief consideration in the Relation of Chemistry to Health and Disease is the future progress of medicine with the aid of chemistry. Besides the constant important discoveries of remedies for the many unconquered diseases which still besiege mankind today, there are three wide fields open to great advancement from chemical research. These three fields are: the task of isolating the principles of serums; the study of food; and last and most important of all, the chemistry of the body cells.

Antitoxins, bacterial vaccines, and serums are now much used in the cure and prevention of many contagious diseases, such as diphtheria, scarlet fever, meningitis, and many others. The fluids used for injection contain many impurities which often cause fatal results when such fluids have to be injected in large quantities.

Physicians realize, for instance, the great possibility of curing pneumonia by the antipneumococcus serum, but the pure principle of this serum is

evidently in very small proportions. So much of the serum has to be inoculated that there is great danger of an anaphylactic shock and other complications.

Antitoxins, when injected into a person suffering from endocarditis, fail to have any effect, because, on account of the many useless impurities, physicians are not able to inject it in sufficient quantities.

It is the chemist who is to isolate the principles of these and many other serums, so that having once got rid of the impurities, doctors may with small strong doses of the pure principle effect rapid cures, unattended by the harmful and even fatal results of inoculating into a patient a serum containing numerous poisons as well as the curing fluid. Much success in this line of research has already favored the efforts of chemistry, but by far the greater field of progress lies ahead.

In the endeavor to promote health and combat disease, a great field even more important than the work on serums, is the study of food. In the support of life the chief functions of food are to supply the body with energy and heat, to rebuild the waste tissues, and to regulate certain body processes. It is evident that under usual conditions the food which we eat generally renders the body these services, but this is not always the case. Chemists have done much work in analyzing food products such as carbohydrates, fats, and proteins, but the greatest achievements still lie in the future. A great deal of work has been done by such men as Lusk, Sherman, and McCollum on food and its relation to the body processes. The work of the chemist Emil Fischer on the chemistry of the Sugars has been the basis for all the modern work on diabetes. Although it does not cure diabetes, the new principle, insulin, gives the diabetic much relief by enabling him to assimilate carbohydrates.

The lack of certain vital principles, called vitamins, has been found by the chemists to be the cause of diseases such as scurvy and beri-beri. Foods have been analyzed and classified according to whether or not they contained these vitamins. As a result of these researches the world will be relieved of two of its great ills.

Recent work, based on others of Fischer's researches, this time on protein metabolism, has brought to light that, although the common ingredients of all foods furnish most of the bodily needs, our body has certain vital needs which our everyday foods cannot furnish. To find out exactly what these needs are, to discover methods, either natural or artificial, of satisfying them, is the goal which, if attained, will alleviate, even do away with countless nutritive diseases.

But by far the greatest of the many triumphs which the future holds for chemo-medical research is the discovery of the secret of the structure of our body cells. Our life is the gradual evolution of the cell. The fundamental structure of our body is the mass of cells of which we are made up.

These cells are constantly being worn out and replaced. Our bodies are, then, the highest illustration of composition and transformation of matter. To learn the chemical composition of the cells, how each substance in the cell is replaced, would be a supreme triumph to the ideals of chemistry alone, without considering the infinite value of such a discovery to medicine.

The importance of the discovery of the structure of the cells to medicine, however, must be considered here in brief. Today physicians realize that many of the ills and diseases of mankind are due to cellular disturbances. If, therefore, the structure and composition of the cells were known, would not this knowledge be of inestimable aid in preventing many of the diseases and physical disturbances which now afflict suffering humanity? The answer is, inevitably, yes.

The cell is the secret of our life. With accurate knowledge of the composition and structure of the cell will come a complete understanding of life—a knowledge of the substances, characteristics, or properties which distinguish a lifeless from a living body.

Now that physicians have awakened to the close relationship between chemistry and medicine, we may take the result of this awakening as grounds for what the future holds for chemo-medical research. With curative and preventive principles perfected, with a thorough understanding of the composition and functions of our various foods, with an accurate knowledge of the structure and composition of the body cell, disease should cease to be. What a wonderful world this would be three or four hundred years from now if everyone possessed perfect health—health, the result of the years of combined toil of chemists and medical men! Today such a Utopia as a world without disease seems entirely possible. Civilization and progress go hand in hand; so:

" . . . . . Forward, forward let us range,
Let the great world spin forever down the ringing grooves of change."

THE RELATION OF CHEMISTRY TO THE ENRICHMENT OF LIFE*

HENRY S. SINGLETARY, JR., PORT ARTHUR HIGH SCHOOL, PORT ARTHUR, TEXAS

Chemistry, the thought stimulant, has given me a glimpse of new worlds to conquer. It has caused me to think about things never dreamed of before. It has revealed to me some of the wonders of this great age in which we live. It has uncovered the beauties of nature. It has made me see the problems and public questions of the day in a new light. Chemistry has firmly established its relationship to the enrichment of my life,

* Prize-winning essay (1924–25).

by stimulating me to think. No greater riches could come to anyone than through the stimulation of thought.

Come with me while I tell you about these riches, the product of thought stimulation. The history of chemistry is a record of sacrifice and service. Chemistry knows no political boundaries; she recruits her conquering chieftains from all climes and races. In this field all are co-workers, and pride is not of races or of traditions, but of achievement in the interest of humanity. To read the lives of these great chemists is to get an inspiration. It makes you see that the true value of life is measured in terms of sacrifice and service.

The study of chemistry makes you a seeker after truth. It teaches you to observe carefully, to think straight, and then to record clearly and honestly and to draw warranted conclusions based on the facts presented, free from previous preconceptions and prejudice. It fills you with charity, tolerance, broadmindedness, patience, persistence, and a very high regard for your fellow man. Chemistry is a death blow to mob thought, so prevalent in this day. Chemistry teaches men to be free from superstition and fear of the unknown, so that he examines things for himself with understanding, weighs the facts and draws correct conclusions. Inoculate public opinion with chemistry, the thought stimulant, and quacks, demagogues, morons, fanatics, and radicals will not have such a fertile field in which to work.

The history of the world holds for me a new interest since my study of chemistry. I have come to know something about the geographical distribution of resources of the globe. I can understand something of the motives behind the great wars of history, and to perceive what influences have been at work in the making of treaties. Germany needed coal and iron, so she took Alsace and Lorraine. England needed nitrates so she kept the seas open to Chile. The Spanish, Portuguese, Dutch, English, Danes, and French fought over the sugar of the West Indies. It is interesting to follow the chemist with his explosives, while he shot away autocracy. It is interesting to see him snatch the riches of silks and calicoes, food and drink, perfumes and luxuries from the hands of autocracy and give them to democracy.

There is a close relationship between statesmanship and chemistry. A knowledge of chemistry is necessary to an intelligent understanding of some of our tariff schedules. Chemistry plays an important part in our pure food laws. Statesmen should know chemistry, so as to be able to protect us against imposters and fakers. The questions of economy and conservation are largely questions of chemistry. How can a statesman discuss the Muscle Shoals problem intelligently without a knowledge of chemistry? Thus you see chemistry, the thought stimulant, may influence one's life and opinion on subjects quite remote from chemical things.

My study of chemistry has stimulated me to think more deeply, and, I hope more intelligently, about things around me. The chemist is no longer a wizard, but a philosopher. Atoms and molecules are not symbols of a dead mysticism, but realities of a live science. I cannot see them but I can weigh them. I can make them do as I say. I can perceive a new beauty in many things around me. Now, as I sit before the fire and see an ugly piece of coal burn, it tickles my imagination and stimulates my brain. I think of the B.T.U's. being given off which, turned into horsepower, run the world. I think of the gas being given off which furnished power and light. The most wonderful part of the coal is seen only when the combustion is bad, that is the "coal tar." I think of the day when "coal tar" was considered a nuisance and thrown away. I think of this day when the chemist has taken the waste product and made it to wound and to heal, to supply munitions and medicines, perfume, and sweetness. It is a most wonderful example of creative chemistry. It seems to me I can see the chemist take those structural molecules and make a substitution here and a slight change there, with the precision of a skilled workman until he has produced those beautiful aniline dyes too numerous to count. I can visualize carbolic acid made into salicylic acid, a remedy for rheumatism. Salicylic acid plus concentrated acetic acid gives us aspirin and antipyrin. Then comes the blessing of mankind, the local anesthetics, eucaine and novocaine. This old ugly chunk of coal, also, pleases the eye in the moving pictures by giving us the photographic developers. It tickles the nose and palate with perfumes and flavors.

Let us take on a little more stimulation from my new acquaintance, cellulose, which is found in forest and field. Just to think, this is my old friend, paper, and I did not know it until I studied chemistry. Now, when I look upon it, I think of guncotton and artificial silk.

Now, the blowing of the refinery whistles mean more to me than the mere time of day. I think of hydrocarbon molecules tumbling about in the stills until they get so hot, they break loose from one another. I think of those lubricants which form a film between economy and waste. Snowy white paraffin coming from the liquid black gold is not so much a mystery as it was at one time. I am gradually learning something about benzene rings and the breaking up of heavy hydrocarbons into light hydrocarbons, which is caused by heat and pressure and is known as cracking. This brings me back to my old friend the tetravalent carbon atom and its peculiarities. When I think of the marvelous things that have been done by creative chemistry in the "coal tar" industry, chemistry, my thought stimulant, forces me to think that petroleum, with its mixture of hydrocarbons, holds many a secret yet unknown to the world. Isoprene is a double-bond compound from cracked petroleum, and rubber can be made from it. Aluminum chloride is used for cracking purposes, at the

Gulf Refinery, and rubber can be made from aluminum naphthenate. Petroleum resins are attracting considerable attention. Another thing that comes to my mind, when I hear the refinery whistle blow, is the problem of corrosion. Corrosion causes millions of dollars of loss every year. It is nothing more than iron trying to get back into its natural state of oxidation. It is a problem well worth thinking about.

Listen to the honk of the automobile. What does it mean? Just a chance to get a ride? No, more than that. I think of the gasoline in terms of molecules and wonder if they are straight-run or cracked. I hear the backfire and I know that they are not using tetra-ethyl lead. I think of that wonderful combination of alloys that makes the engine possible. I look at the tires and think of that revolutionizing accident, vulcanized tires.

Port Arthur is surrounded by riches that I seldom thought of until I found chemistry, the greatest thought stimulant in my whole high-school curriculum. Sulfuric acid is the barometer of the chemical world. Sulfur, its main constituent, is found at the very doors of Port Arthur, in inexhaustible quantities. Our sand beds produce silicon. Our salt mines give us sodium chloride. Our oil wells give us petroleum. Our forests give us cellulose. We have nitrogen and oxygen in the air. What wonderful possibilities. We could take the nitrogen, oxidize our sulfur to sulfuric acid, remove the cellulose from our wood, and make the most deadly explosives or the most beautiful silk. By passing an electric current through sodium chloride, we could get sodium and chlorine; with our sulfur and chlorine we could make mustard gas. Combining our silicon and chlorine to get silicon chloride and our nitrogen with hydrogen to get ammonia, and bringing the two together, we would get a smoke screen that would hide us from the world.

Let us go out among the plants and see what interesting things we can find. There is the little green leaf in the sunshine, bringing carbon into combination with hydrogen quietly and without getting hot about it. Man takes a thousand horsepower engine and an electric furnace at several thousand degrees to get the same result. We find that plant life makes many things cheaper than we can. The soil feeds the plant and man has to feed the soil. Out of the eighty elements, thirteen are necessary to plant life. These are grouped into gases, metals and nonmetallic solids. The gases are hydrogen, oxygen, nitrogen, and chlorine. The metals are potassium, magnesium, calcium, iron, and sodium. There are four non-metallic solids, these being carbon, sulfur, phosphorus, and silicon. The only three we have to worry about are nitrogen, potassium, and phosphorus. Nitrogen is plentiful but is not good unless fixed, the nitrogen-fixing bacteria of the roots of peas seem to know more about this than man. The nitrate of Chile is the main source. Potassium is

found in many combinations, but is difficult to separate from its associate. The potash salt of Germany is the main source. The rock phosphates of Florida furnish an abundant supply of phosphorus. Agriculture demands that we find some way to give the farmer cheap nitrates and cheap potash. This problem should stimulate us to do some thinking. It means not only the prosperity, but the defense of our nation.

Doctor Charles H. Mayo, the famous Rochester, Minnesota, surgeon, states that the average man's body would furnish fat enough to make seven bars of soap, iron enough for a medium sized nail, sugar enough to fill a salt shaker, lime enough to whitewash a chicken coop, phosphorus enough to make the tips of two thousand two hundred matches, magnesium enough for a dose of magnesia, potassium enough to explode a toy cannon, and sulfur enough to rid a dog of fleas. The total value is said to be about ninety cents. To some, this cold-blooded statement may indicate a stingy creator and a cheap man, but to me it is wonderful. Only Deity could take such poor material and by combination and arrangment fashion it into man, the image of his Creator. The chemist has begun to study the make-up of man. He has found that disorders that shorten life cause chemical disturbances in the body which might be corrected by chemical treatment. When we see thyroxin changing an idiot into an intelligent human being, when we see insulin, that sugar-consuming principle from the pancreas, relieving and prolonging the life of people with diabetes, is it visionary to hope that chemicals required in the million mysterious processes which go to make up human life, may one day be manufactured synthetically in the chemical laboratory? If it is, it is a very pleasant dream. I hope the day is not far distant when the government will look upon chemistry as an aid to human life and not as the old war-time agent of death. May the time come when the chemists will be mobilized to solve the problems of life, not of war.

In studying about that wonderful element "radium" which has caused such a stir among chemists, I find that atoms of helium are given off by it. The largest supply of helium in the world is found in a certain natural gas in Texas. If helium is given off by radium perhaps this gas rich in helium is coming from a rich source of radium, somewhere in the state of Texas. This may be a foolish dream of a school boy caused by my thought stimulant which is making me see visions and dream dreams.

In reading about structural molecules and atomic structure, I am getting a hazy understanding of atomic-planetary systems. Negative charged electrons revolving around a positive charged nucleus held in their orbits by the old law "like electricity repels and unlike electricity attracts."

Working under the influence of chemistry, the thought stimulant, I am determined to further enrich my life by more fully understanding

the substances of which our earth consists, their composition and manner of decomposition, and especially their behavior towards one another.

Let us dream no longer of Aladdin's lamp and magicians with their magic wands in a mythical past. Let us act in the living present, hand in hand with this revealing philosopher of life, chemistry. Let cynicism be repudiated. Let us go as little children with open minds and hearts, seeking but truth; let us turn our eyes toward the window of the future to catch a glimpse of a fuller and richer life and the dawn of a superday.

THE RELATION OF CHEMISTRY TO AGRICULTURE*

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The great problem before the agriculturist today is to supply food and clothing for the steadily increasing population of the world, and it is only with the aid of the creative chemist that this can be done. In ancient times, and, in fact, not until a comparatively short time ago did this problem seem an alarming one.

When men first began to settle down and earn their livelihood by tilling the soil, they had only the needs of their own families to supply; but, as society became more complicated and people began to specialize more, they became dependent upon one another. To the agriculturist has fallen the greatest responsibility, because it is upon him that the other members of the modern industrial system are dependent for the raw materials which supply them with food and clothing, the very basis of their existence, as well as with other products needed for carrying on their various industries.

Since ancient times one of the greatest difficulties of the agriculturist has been to maintain the fertility of the soil. At first, he would abandon his fields when they became unfertile, and move to a more favorable locality; but this method he soon improved upon by practicing crop rotation. After a time he discovered that food was what the soil needed, and so he set to work to supply this need. Having no scientific knowledge to guide him, he could do this only in a haphazard way; but, as luck would have it, he adopted very effective methods. From Virgil's lines:

> *"But sweet vicissitudes of rest and toil*
> *Make easy labor and renew the soil.*
> *Yet sprinkle sordid ashes all around*
> *And load with fattening dung thy fallow soil."*

we learn that over two thousand years ago there were being used as fer-

* Prize-winning Essay (1924–25).

tilizers nitrate, potash, and phosphate—the three of the thirteen elements necessary to plant life which are not supplied in sufficient quantities in the soil. The nitrate and the phosphate were supplied by the dung and the potash by the ashes. Efficient as these methods were in ancient times they cannot meet the modern needs. Whenever natural deposits of fertilizers were found they were drawn upon; but they in time became exhausted.

Today practically all the farm lands have been settled and the world has become so densely populated that a plan of intensive farming must be followed; that is, larger crops must be produced on smaller tracts of land. This can be accomplished only by heavy fertilization. When we know that the only large natural deposits which remain at the present time are the potash beds of Germany, the nitrate beds of Chile, and the phosphate deposits of the United States, and that these will not last forever, we realize how serious the situation is. Fortunately the chemists have come to our rescue.

The chemists have given their attention to agriculture for only about fifty or sixty years; but, in that time, they have accomplished marvels. They have determined what elements are taken from the soil by certain crops, and, knowing that the natural supplies of these elements will, in time, be exhausted, have gone to work to supply them by artificial means.

Nitrogen is the element which must be supplied to the soil in the greatest quantity. The first step toward supplying this need was made when the chemists, with the aid of the biologists, discovered that nitrogen is not used by plants in the free state, but only after it has been "fixed," or converted into nitrates. They learned that the conversion is made by certain bacteria which live in the soil and in the nodules on the roots of leguminous plants. The chemists then began to raise these organisms by the billions and to ship them to the farmers who applied them to the soil by inoculating the seed with them, or by simply burying them in the soil at a depth of several inches. This method of procuring nitrogen soon proved impractical, because, unless soil conditions were just right for their growth, the bacteria died and the farmer lost his money invested in them. Knowing that seventy-eight parts of the air are free nitrogen, the chemists began to search about for a means of fixing atmospheric nitrogen. They obtained a clue upon which to work when they discovered that Nature fixes the nitrogen of the air by means of the lightning bolt. In 1903 the Norwegian chemists Birkeland and Eyde succeeded in fixing the nitrogen of the air by means of the electric arc. In 1911 the German chemist, Haber, discovered a means of fixing atmospheric nitrogen by heating nitrogen and hydrogen under pressure in the presence of a suitable catalyst. The chemists of other countries are now experimenting along

these lines with great success, and have made it fairly certain that an inexhaustible supply of nitrogen will soon be available to the agriculturist.

The problem of procuring an artificial supply of phosphate has also been solved. A few years ago the chemists discovered the value as a fertilizer of phosphatic slag, which for years had been considered a worthless refuse in the iron industry. By a very simple process the chemist can remove this phosphorus and make it available as a plant food. The phosphate procured in this way contains a higher percentage of phosphorus available to the plant than do the natural phosphates.

In the preparation of artificial potash, the chemists, have not yet met with quite so much success. The refuse from many of our industries may be converted into potash, but the amount obtained in this way is not great enough to meet the demand. For instance, near Riverside, California, there is a large cement plant which had for years been a source of annoyance to the community because of the dust that was allowed to escape into the air and settle upon the surrounding country. During the war, when chemists were searching every nook and cranny for potash to tide the American agriculturists over the crisis due to the inability to obtain German potash fertilizers, they discovered that the dust was rich in potash. A means of collecting the dust was devised. This was then sold to the citrus growers, and proved a great help in the time of need. Likewise molasses, a former waste product of the beet-sugar industry, is now utilized by the chemist as a source of potash. Fish refuse and wool wastes are also used, but are available only in small amounts. Potash is found in large quantities in alkali lakes in many of our western states, but it is mixed with so great an amount of soda salts that to separate it is a very difficult and expensive process. During the war, potash was made from seaweed which was obtained from the large beds off the coast of California. The chemists thought for a time that this would solve the problem, but the process used is too expensive to be entirely practical in peace times. Although the chemists have as yet been unsuccessful in producing a supply of potash which can be sold at moderate prices, they feel confident that they will do so in the course of time.

Chemistry has rendered an enormous service to the agriculturist by supplying him with chemical fertilizers, but this is by no means the only way in which it has aided him. Nothing could be much more disheartening to the agriculturist than to have his crops destroyed by pests and disease. The saying, "There is a bug for every bush" has long seemed true to the farmer; but, since the chemists have begun to aid him in his fight against pests and disease, it seems as if there were a spray for every bug. A new pest is no sooner discovered than the chemist sets to work to find a means of destroying it. By furnishing the agriculturist with sprays such as calcium arsenate which is used in combating that

wholesale destroyer, the cotton-boll weevil; by supplying him with poisonous gases such as the hydrocyanic acid gas used for fumigation to destroy the scale insects on citrus trees; by supplying him with poisons for destroying rodents; and by furnishing him with the various vaccines, antitoxins, dips, sprays, dusts, and medicines that are now being used with such successful results in the livestock industry, the chemist has saved the agriculturist billions of dollars.

The chemist is a great economizer. If he sees anything going to waste, he immediately begins to work out a way in which it can be utilized. By doing this he has greatly increased the value of many agricultural products. Cotton was formerly raised only for the fiber; but today, because of the efforts of hundreds of chemists who have made the study of cotton their life work, the seed is just as marketable as the fiber. The seed is composed of the linters, as the fuzz which is left attached to it after the cotton has been run through the gin is called, a thin, woody hull, and a meaty kernel which is divided into two parts, the oil and the starchy part, called the cake, which is left after the oil has been removed. The chemists have found use for the linters in making cotton batting, wadding, absorbent cotton, felt, artificial leather, low-grade yarns used for twine, candle wicks, rope, and the like, and cellulose which is used in the manufacture of artificial silk, celluloid toilet articles, and writing paper. The cake and the hull, which is made into a meal, are used as fertilizers, as a food for livestock, as a food for human consumption in the form of certain confections and of flour used in making bread, crackers, and cake, and in the manufacture of dyestuffs. The oil is refined and the lower grade used in making soap, washing powder, dyestuffs, glycerol, roofing tar, and paint. The higher grade oil is used in making lard and butter substitutes and salad oils, in packing sardines, in making soap, medicinal emulsions, cosmetics, and candles, as a lubricating oil, and as an oil for mixing paints. The chemist has not confined his efforts to cotton only. In the citrus industry cull oranges and lemons are now used for making marmalade and citric acid. Apple parings, which until lately were used only for making vinegar or for a hog food, are now utilized for making fruit pectin, which is saving the housewife so much time in her jelly making. Indeed, there is no branch of agriculture in which the chemist either has not found a use for the by-products or is busily trying to do so.

Aside from the utilization of by-products, the chemists have put agriculture on a much more economical basis by soil analysis. In the United States a survey is being made of all farm lands to enable the farmer to know what crops can be most profitably grown in his locality. If any imaginable crop can be grown in any part of the United States the chemists know it, or, if they do not, will make experiments to find out, and so it is

no longer necessary for the farmer to waste time and money in experimenting with new crops.

There are certain agricultural products which can be grown profitably only in direct coöperation with the chemist. For instance, the growing of sugar beets would never have become the profitable industry which it is today if the chemists had not discovered that the beets contain a large percentage of sugar, and invented a means of extracting it and preparing it for consumption.

There are other products for which the agriculturist is entirely indebted to the chemists. It was the chemist who distinguished between the edible and nutritious mushroom and the poisonous varieties and encouraged its cultivation as a food product. It is entirely due to their efforts that the flourishing industry of mushroom farming has been established.

It is the chemists who have made possible the intensive agriculture which present conditions demand. They have done this by assuring the agriculturist that in the near future there will be an inexhaustible supply of chemical fertilizers, by freeing him from great losses formerly suffered by furnishing him with means of combatting pests and disease, by making it possible for him to employ all his resources and energy in production, by making experiments unneccessary, and by enabling him to obtain more produce to the acre by reducing waste to the minimun. Knowing this, the problem of supplying our ever-increasing population with the necessities of life does not seem such an alarming one.

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THE RELATION OF CHEMISTRY TO NATIONAL DEFENSE*

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Major Victor Lefebure, in his authoritative book "The Riddle of the Rhine," unqualifiedly states that any nation which possesses a monopoly of the organic chemical industry thereby has the power to conquer the earth and Major Lefebure backs up this statement by incontrovertible facts which it will be my aim to make clear. This power to conquer is regardless of existing limitations imposed by the laws of war and of any

* Prize-winning Essay (1924–25).

future limitations, for it is based upon industries essential not only to the production of war materials but also to the development of civilization. To cite typical instances, these industries provide phenol, from which are made not only some of the finest synthetic dyes which we know but also some of our most deadly gases; they provide nitric acid, from which are made not only the most violent explosives but also indispensable fertilizers. Furthermore, the intermediate processes for making these dyes and nitrates are readily convertible at a moment's notice for the wholesale production of those deadly gases which are the controlling feature of modern warfare. Thus from the very nature of the industry we cannot limit by any act or law the undesirable features without destroying the indispensable ones. As for mutual agreements, it is axiomatic that any nation fighting for its life will use every method it can devise. (Indeed, General Fries, Chief of the Chemical Warfare Service, emphatically states that he would favor our public announcement that if we are drawn into war we will use every method at our disposal.)[1] There remains, therefore, only one solution for the maintenance of peace, that the industries arising from organic chemistry be fairly equally divided among the nations. But Germany, with her great dye combination, the *Interessen Gemeinschaft*, commonly known as the I. G., had in 1914, by a system of dumping to undersell competitors, succeeded in gaining a practical monopoly. Naturally the war gave a terrific stimulus to this organization, for the substances which they were required to produce were essentially the same as those which they had been producing and expected later to produce; on the other hand, the infant industries of the Allies were incapable of assuming the full burden of production and those additional plants which were built were built for the purpose of immediately countering German attacks at the front rather than with any definite purpose of future economic advantage. Thus when the war ended, it was found that many of these plants were incapable of economical commercial production, while the I. G., greatly strengthened by the war, proceeded to attempt to regain the dye monopoly.

The present situation, then, is as follows: gas warfare has, because of research and development, become much more effective, and because of agreements limiting the use of other weapons has become of much greater *relative* importance. At the same time we must face the fact that Germany, because of her prosperous dye combine, has an inordinately great potential gas strength.

As a first step towards a conception of the part which chemistry plays in modern warfare, it is imperative to have an idea of the multitude of branches into which chemistry enters. Let us first consider some branches which are least obvious. In the first place we have such matters as food

[1] "Chemical Warfare," p. 371, McGraw-Hill Co., New York, 1921.

and medicine, equally important in peace and in war. The chief importance of chemistry to food is in the solution of the problem of preservation. This is a matter of primary importance to a moving army, and has been successfully solved by the application of chemistry.

Chemical anesthetics and antiseptics of even higher quality than those provided by nature have greatly lessened the tasks of the surgeon. Eucaine, novocaine, and zonite are typical examples, and are indispensable in time of war.

The chemistry of metals is a highly developed science essential to the manufacture of all the weapons of war through the invention of suitable alloys and of suitable tool-steels for efficient production. Ship-armor, heavy ordnance, shells, rifle and machine-gun parts, all are dependent on chemically constituted tool-steels, alloys of iron with chromium, tungsten, or vanadium. Aluminum and its alloys have made possible the development of airplanes; without the application of chemistry the extraction of aluminum from its ore would be impossible. Innumerable examples of the importance of high development of the science of metallurgy could be cited, but these few instances are adequate to show the tremendous part which it plays in modern warfare.

Now we come to one of the first things which we think of in connection with chemistry in warfare, the manufacture of high explosives. All high explosives contain nitrogen compounds, the source of which will be taken up later. High explosives are divided into three classes. First we have those like "cordite," which was discovered by Nobel in 1878. The explosives of this class are different mixtures of nitro-glycerin and nitrocellulose. The second class contains explosives made from picric acid, which in turn is made by the action of sulfuric and nitric acids on carbolic acid, the phenol obtained from coal tar. The explosives of the third class have as their base toluol, another tar product. When treated with nitric acid, it forms tri-nitro-toluol, familiarly known as T.N.T. We need not discuss the uses of these explosives, as we all know how their use has forced warfare from the fixed fort to the dug-in trench.

Let us now discuss a form of warfare which has come into being only during the last decade. I refer to "gas" warfare, really a misnomer, as most of the substances used are under ordinary conditions not gases but liquids or solids. These gases can be classified according to their effects on the human system. First come those which are injurious only to the respiratory system, and then only in high concentrations. These gases are effective only in surprise actions or against unprotected troops, as masks afford complete protection. This group contains chlorine and phosgene, the latter a compound of chlorine with carbon monoxide.

A second group is irritating to the eyes in very low concentrations, causing temporary blindness with weeping; the members of this group

are poisonous only in very high concentrations and there is no evidence that in any case was injury permanent. Production of these gases is difficult, but is balanced by the fact that very low concentrations are effective. The principal constituent of these lachrymators is bromine, used extensively in the dye industry, though the present standard tear gas is chloroacetophenone.

The third group is made up for the most part of arsenic compounds, for example, diphenylchlorarsine. These compounds form particulate clouds which are quite effective in piercing masks. In low concentrations these gases merely cause sneezing, but in higher concentrations they cause pains in the head and death.

The fourth class contains only one gas, dichlorodiethyl sulfide, "mustard" gas, designed to attack and blister the skin. The Germans produced this gas easily with but little change in their existing apparatus, while the Allies were able to use it on the field only after a full year of organization. Though mustard got into the war very late, it was responsible for a great number of casualties, as it is impossible to protect the body from its blistering effects, while the gas is so persistent that it often remains dangerous as much as a week after it has been used in a given area. It is for this reason the most effective gas developed.

Phosphorus is of great importance in the formation of smoke clouds, the values of which have been investigated principally since the war. Their use in future wars to disguise movements of forces and presence of toxic gases will undoubtedly be great. Phosphorus also finds a large use as an incendiary.

It is unfortunate that the exigencies of space forbid discussion of the other twenty-odd substances in general use, but those mentioned are representative and serve to convey a general idea of the chemical weapons at the disposal of ourselves and our enemies.

The power of a nation in war depends obviously quite as much on production as on the effectiveness of the actual weapons used, and in no branch of warfare is this truer than in chemical warfare. But here we find that government arsenals are not the only effective plants for manufacturing chemical weapons, for the entire organic chemical industry, and in particular that branch devoted to the manufacture of aniline dyes, is suited to immediate adaptation for wholesale production of all gases used in warfare. No better proof of this can be given than a comparison between the United States and Germany in respect to production of chemical weapons during the Great War. In 1917 the United States found itself very deficient in chemical industries and was able to enlist in its service for manufacture of gases only four companies. The government therefore decided to build a chemical arsenal at Gunpowder Reservation, Md., later called Edgewood Arsenal. In the spring of 1918

the plant began manufacturing, and toward the end of the war furnished as much as 1,300,000 pounds of chlorine and phosgene, 1,000,000 of chloropicrin, and 700,000 of mustard a month.

But Germany did not have to build an arsenal. The whole matter was turned over to the I. G. and production started almost immediately upon the decision to use any given gas. Chlorine and phosgene, already extensively used in the dye industry, were available without conversion of equipment. Mustard gas production attained 300 tons per month in spite of a complicated four-step process. Diphenylchloroarsine was manufactured successfully, again in spite of an intricate four-step process, all four steps being readily made in existing apparatus without fundamental change. These are fair examples of the ease and rapidity with which the I. G. was able to manufacture these compounds which they were called upon to produce. Furthermore, Germany thus avoided the creation of a complex chemical warfare service, a fact which rendered her adoption of new chemical weapons infinitely more facile than that of the Allies.

But the factories of the I. G. did not produce poisonous gases alone, for they furnished practically all of Germany's high explosives. Indeed, Major Lefebure states that it took only six weeks for the conversion of the dye plant at Leverkuson into a plant producing T.N.T. at a rate of 250 tons per month.

On further examination we find that the dye industry is dependent upon and fosters the development of two important industries, that producing nitrogen compounds and that producing coal tar. Nitric acid is essential to the dye industry in numberless instances, and this industry is one of the chief consumers of that agent.

We must not suppose, however, that nitrogen compounds are necessary to the manufacture of dyes and explosives alone, for they find one of their most essential uses in fertilizers. Nitrates form one of three important constituents of fertilizers, the others being potash and phosphate. We have a quite sufficient supply of natural phosphates, but our potash and nitrates are imported. To be sure, some sources of potash have been explored, for example, extraction from sea-weed, but such sources are not commercially profitable. As for nitrates, we can, if we will, obtain these from the air by fixation at the temperature of the electric arc. Fertilizers will become increasingly necessary to us, for practically all our fertile lands are now under cultivation, and the question of replenishing the soil must soon become paramount. We are running a tremendous risk if we content ourselves with relying on foreign sources of nitrate, for in the event of war not only our weapons may be crippled, but our very food supply may be restricted.

The second industry on which the dye industry is dependent is the coal tar industry. This provides coal tar crudes, benzene, toluene, xylene,

phenol, and naphthalene, from which are made the 300 intermediates which in turn are converted into 900 or more dyes. Some of these crudes, for example, toluene and phenol, are also used in high explosives. The United States learned the necessity for coal tar during the war, and now saves more of this invaluable product than any other nation. Nevertheless, 30% of the total production of coke is made in bee-hive ovens, which waste all the tar, while over 300,000,000 tons of coal are burned in homes and factories every year without any recovery. Truly, here is a field for economy.

There are many more chemical industries partially dependent on the dye industry and essential to it, of which none is more important than that producing alcohol. This, either as a solvent or constituent, is indispensable to the dye industry, to the medicine and drug industries, to the manufacture of high explosives, and to the production of chemical weapons, for example, mustard. Here we must emphasize the fact that all chemical industries are inter-dependent, the prosperity of one strengthening all, the deficiency of one endangering all. This is a fact which must never be overlooked in considering chemical industry.

The next war—and that it will come, the lessons of history and the present chaotic state of international affairs give little opportunity to doubt—will be a war of chemistry. That this is true is indicated by the frenzied development of chemical weapons during the great war, while now for seven years all the great powers have been active in *secret* research, discovering no one knows what lethal compounds. Furthermore, progress in aviation has made aircraft, in combination with chemical agents, an extremely grave menace not only against land and sea forces but also against civilian populations. The next war will be a short one, for the terrible effectiveness of aerial attack with chemical weapons will forbid stalemate. But more important still, it will involve the whole industrial structure of civilization in the production of war materials and necessities. This will be particularly true of chemical industry, and any nation deficient in chemical equipment, organization, and trained personnel will be at the mercy of an aggressive power.

When, however, we realize that well developed chemical industries will free us from fear of aggression and will render us economically more independent, what arguments can we bring against the whole-hearted support of these indispensable industries? We must not remain insensible to the vital importance of this question, but must do everything possible to further the prosperity and power of the chemical industries of this country if we hope in the next struggle to be able to send our soldiers to the field of combat with the confidence that they will never be put at a disadvantage which could have been remedied by the foresight and patriotism of the American people.

THE RELATION OF CHEMISTRY TO THE HOME*

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The day is fast receding into the past when "Chemistry" and "Alchemy" were nearly if not entirely synonymous terms, and when "Chemist" suggested an aged seer with hoary beard, or some cunning wretch who spent his time in den or cave concocting subtle poisons, or in seeking to turn dross into gold. It is true that many scholarly monks had pried into the secrets of nature and had discovered the actions and reactions of certain extracts made from roots, flowers, and fruits. An eminent scholar, Albertus Magnus, of the thirteenth century who may be cited as an example declares, "In studying nature we have not to inquire how God the Creator may, as He freely wills, use His creatures to work miracles and thereby show forth His power; we have rather to inquire what Nature with its imminent causes can naturally bring to pass." Albertus Magnus and Roger Bacon, both monks, proved to the world that faith and science go hand in hand, and their lives and writings emphasize the importance of experiment and investigation. The Wayland Smiths and Arbaces of fiction have yielded place to the Pasteurs, the Jenners, the Curies, and a host of men and women who find in the laboratory a field congenial to their tastes, and who employ the knowledge gained there to the affairs of daily life, thereby making this world a healthier, happier abode for their fellow beings.

Woman has been accused of being unable to keep a secret; but her accusers must admit that Dame Nature has kept many of hers a long, long time, and when she did reveal them it was only after long and persistent wooing on the part of those who have devoted their lives to the investigation and experiment. Had these searchers after Mother Nature's secrets been content, however, in merely satisfying their own curiosity, mankind in general would owe them small thanks. It is in the practical application of their findings that chemists have made the world their debtor. So varied and manifold are these applications, that the mere naming of them would amount to a task of bewildering proportions. Even narrowing the subject down to the relation of chemistry to the home furnishes a theme of no small dimensions.

The modern youth, reared in his present environment, accepts as a matter of fact the various contributions to his comfort by men of science. It seldom occurs to him that there was a time when other youths worried along with fewer conveniences, and in their blissful ignorance were none the less enamored of life than he now is.

To awaken such a one to an appreciation of the vast debt the modern world owes to chemistry we shall resort to the "look-on-this-and-then-on-that" method, by contrasting a palace of Queen Elizabeth with the

* Prize-winning Essay (1924–25).

home of a moderately well-to-do American family of today. A hurried survey of Queen Bess's living quarters will no doubt soon convince us that in spite of the romantic glamor cast over them by the spell of poet and bard they are sadly deficient in nearly all the conveniences which we now consider necessary to the life of even ordinary individuals, to say nothing of what we imagine royalty would desire.

Let us invest ourselves with the authority of health inspectors and approach Kenilworth or any of the typical palaces or castles of by-gone days in that capacity. No doubt our sensibilities will receive a shock when we view the outside of these majestic piles—no provision has been made for the disposal of garbage and offal, which are thrown about in the rear of the grounds, and which cause no one any uneasiness. Shrugging our shoulders, we walk around to the front entrance and pass through spacious portals, rubbing elbows with Sir Walter Raleighs, Lord Dudleys, and Earls of This-and-That. Coming in from the warm sunny outdoors, we are struck by the chill and damp of the dim and musty-smelling hall in which we find ourselves; but we soon discover the reason for this in the heavily-draped narrow windows tightly closed, thereby debarring both light and air. Proceeding to the private apartments of the queen we note with surprise the lack of much that milady of today considers essential to her suite. No plumbing of any kind is here. Of course there is no deficit in cosmetics, for Elizabeth's craving for beauty was as great as that of any modern woman. But we shall not loiter over these jars and caskets of pomades, creams, and lotions, for we are concerned in the house proper. Let us descend to the kitchens. Scullions, cooks, and stewards are busy, but nowhere do we see the labor-saving devices of our kitchens—no sinks, for why provide for disposal of dirty water when there are so many idle boys standing about? No refrigerators, for it was not until after Elizabeth had gone to her final reckoning that Francis Bacon proved that snow and ice were preservatives of flesh and foods.

We have seen enough to convince ourselves that the twentieth century is much more to our liking than were "those good old days of yore," so let us return to our own times and land and investigate but superficially the conditions of an average American home. What giant strides has Chemistry made! As we walk along the paved streets we see no litter cluttering gutters or doorways. This contribution to the esthetic Chemistry may claim as its own, because it has discovered that in this same trash which will collect wherever man makes his abode is the breeding-place for germ diseases. We now approach our typical American home. No bleak weather-beaten walls chill us; on the contrary the glossy, pleasing presence of what we call "paint," a preservative substance of oil and pigments, covering the exposed sides of the house, causes even the exte-

rior to be attractive. Entering we find light and fresh air flooding every apartment from sun-parlors and sleeping porches to kitchen and cellar. "Free goods," you will say, "and no thanks to the chemist for them." Yes, sunlight and fresh air are free goods, but they were not appreciated until the chemist brought us the knowledge of their efficiency as germ eradicators. Had this fact been known in Elizabeth's day no doubt the span of life recorded on many a tomb would be longer by a decade or more of years. Let us return to our inspection. Shining floors, woodwork, and furniture proclaim the chemist's presence in the wax and varnish—the former a by-product of the great gushers which have been a source of wealth to many; the latter nature's grudging gift from her pines. The tinted walls and cheerful draperies owe their beauty of coloring to the chemist, who wheedled the secret from coal or ore or herb. Carefully screened doors and windows are silent witnesses that the fly and mosquito are unwelcome—again, in this, we find the thumb mark of the chemist.

Delicious odors reveal the location of the kitchen. Thither we turn our steps. In this most necessary laboratory of the house without which a home is not a home, the chemist fairly screams at us; his presence there is broadcasted by every dish, earthen, china, porcelain, or tin. On shelves, each in its proper place we see baking-powder, soda, yeast, jello—but the list is too long. In every instance the chemist preceded the manufacturer whose name the article bears. In the flour, the sugar, and the salt he has left his trace in its bleached whiteness. Nor has he been indifferent to the food prepared and consumed in the home. He knows that the human body is a laboratory more precise and exacting than the one in which he makes his experiments, so he is interested in directing the housewife in her selection and preparation of the food she serves her family. To reach the greatest number of women and, eventually, homes schools, colleges, and even universities have added to their science departments, schools of Domestic Science, where the art and science of home-making are taught. Not content with this, many, as Ames, for instance, are conducting Extension Work in Home Economics, thereby broadening the field of its usefulness by getting in touch with the housewives who are contending with actual problems in their homes.

From the kitchen let us take a peep into the dining room where the table is laid for dinner. What a tempting variety of food, some cooked and some untouched by fire. Why this distinction? The chemist has found that some foods are more wholesome and contain more vitamins and salts when eaten uncooked; he has also made the discovery that to others heat must be applied in order to liberate or transform certain elements to render them fit for tissue-building. Note the combinations, cheese and macaroni, bread and butter, meat and potatoes—again the chemist.

As we are not invited to dine we shall move on into this neat looking little room which serves as the household dispensary. On the shelves we find simple remedies for cuts, burns, bruises, colds, and other trifling ills to which human flesh is heir.

Through the open door we look into the spotlessly white lavatory, another sanitary convenience for the principle of which we are indebted to the chemist. Not all of Elizabeth's wealth or power could have procured such for her court, for it is only of comparatively modern times that nature has yielded up this secret of hers regarding the hosts of hostile bacteria who wage deadly warfare among themselves—a secret which has been utilized in the septic tank system of sewage disposal in cities, towns, and even in country farmhouses. We bestow but a passing glance at milady's dressing table with its formidable array of cosmetics for cheek, lip, brow, and hair; also at the shaving creams of the master of the house, and at the baby's special preparations.

Aside from these personal debts to the quiet, unostentatious man in the laboratory, above all and before all do we note the pervading sense of the wholesome cleanliness of every nook and corner. True, the mistress of the house receives credit for it, but she must "yield the prize," or both she and the chemist "must divide the crown," for were she left with only her scrubbing brush and clear water to attack her great enemy "dirt," she might wear herself to a shadow without having attained the end in view—a clean, sanitary home. Just what she and the chemist consider "dirt" is aptly explained in the following: "This business of removing dirt offers a variety of chemical problems. Dirt is a very large term. To the bacteriologist it means one thing; to the housewife, another; and to the child making mud pies, it has a very different meaning. The bacteriologist usually means that the presence of germs indicates dirt, while the housewife means dust or grease spots or tarnish."

As long as 3000 years ago the ancient Egyptians had discovered that the use of palm and olive oils would keep their skin smooth and soft. Cleopatra's sumptuous marble bath—not to be confused with our ideas of sumptuous—was supplied with flagons of palm and olive oils. But even before these toilet preparations, which have been improved upon by the chemist, were in vogue, womankind was employing sand and saponaceous roots and juices to cleanse her cooking utensils, and clothing. In course of time, by dint of experiment, various cleansing agents were evolved from oils and fats, both vegetable and animal. Perhaps the chemical principles involved were known imperfectly or were only guessed at; but now the chemist's understanding of the composition of elements and their affinities and aversions has given the world soaps, Dutch Cleansers, Sapolios, and Bon Amis too numerous to mention. He has taught the

housewife how to remove ink, fruit, grass, and paint stains, rust and mildew by simple close-at-hand remedies.

Not only has he taught her many things to do in certain cases, but he has also instructed her in what not to do—as, for instance; not to pour hot water and lye into the kitchen-sink in order to clean out the grease which has collected there; not to put soiled clothes into hot water; not to clean hard-wood floors with lye. He has lightened the drudgery of laundrying and house-cleaning; in short he has made his knowledge adaptable to so many phases of home life that the mother of a family, even when unassisted by maids, is no longer the drudge, but is the queen of her household. She is enabled to preserve her strength, energy, and good looks much longer than her mother and grandmother could, and at the same time find leisure to enjoy social intercourse with family and friends, and to improve her mind by reading and study. To continue the list of helps and warnings the chemist has given the modern home-maker would no doubt furnish much food for thought and also awaken many to a sense of gratitude toward the patient experimenter in the laboratory who is only too often regarded as an idle dreamer, but it would extend this paper far beyond the limits assigned. I shall only say in conclusion that hasty and superficial as has been my survey of this phase of the application of Chemistry I have learned that to the chemist civilization owes a debt whose magnitude could be appreciated only by striking out from our homes and lives whatever can be attributed to him; and were this done, civilization's descent would be headlong and astounding.

THE RELATION OF CHEMISTRY TO THE DEVELOPMENT OF THE IRON AND STEEL INDUSTRY IN THE UNITED STATES*

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Practically everything that surrounds us in our life today, whether associated with our homes or our occupations, our necessities or our luxuries, traces its manufacture by man to his ability to smelt iron and to refine it into the many modifications of what we call steel. Choose anything you wish which is common in everyday life, and ask yourself whether iron or steel has had anything to do with its appearance in its present form. The answer will surely convince you that whatever else we may be accomplishing in this world in the advancement and progress of religion, science, industry, and art, we are characterized, first of all, as a people who are becoming more powerful through our knowledge and ability to produce and work cheaply iron and steel in their various forms.

* Prize-winning Essay (1924–25).

Every path of progress in the iron and steel industry has been blazed by the chemical laboratory.

Iron is prehistoric. In Genesis IV, 22, Tubal-Cain, who was seven generations from Adam, is mentioned as "the forger of every cutting instrument of brass and iron." While it is true that iron has ever been man's most useful metal, his knowledge of it was largely mechanical until the middle of the sixteenth century when one Georgius Agricola published a book on metallurgy which took him twenty years to prepare. This book was so carefully written that it was not excelled for several centuries, and its value to the men who followed in this profession can scarcely be gaged.

As early as 1608 iron ore was exported from Jamestown, Virginia, and in 1619 charcoal furnaces and small forges were built at Falling Creek, Virginia. It was here that the chemist first came to the rescue of the iron industry in America. It was discovered that the iron they smelted was of inferior quality, being hard and brittle. The trouble was overcome by what is now known as "fire assaying," which consisted of roasting the ore and separating the metal with a magnet. This roasting eliminated the sulfur from the pyrites ore, and thus the chemist saved the first venture in iron making in America.

The commonly accepted term, steel, means iron alloyed with carbon and smaller portions of manganese or silicon, together with the phosphorus and sulfur that could not be removed by oxidation or fluxes in the process of manufacture. When "alloy steel" is referred to, it is understood that the above, usually called "carbon steel," is alloyed with another metal such as nickel, chromium, vanadium, tungsten, copper, etc. In fact, so numerous are these metals and their combinations that some chemical engineer every year discovers a new alloy steel especially adapted to some particular use. Iron for a magnet must be nearly free from all impurities. Steel for the farmer's fence must be pliable, thus low in carbon. Steel for railroad tracks must be high in carbon to give reasonable wearing service. Steel for screws must contain the otherwise objectionable sulfur. Steel for sheet metal must contain some phosphorus to prevent the sheets from sticking in the process of manufacture. Steel for large ship propeller shafts contain nickel to increase their torque. To make steel non-corrosive copper is added. Tungsten is used as an alloy for some of the best high-speed tool steels. Each one of the above-mentioned practices clearly shows the guiding influence of chemistry in the iron and steel industry. There are many scores of equally well established practices and a vastly greater number of equally important ones worked out by the chemist, but not yet generally adopted by the iron and steel industry because the trade does not demand the product.

Recent years have witnessed a very decided "trend of the trade" to

seek the advice of the chemist in studying its individual requirements. Very few large buyers of steel now purchase by "brand." Instead, the large customer now has a well-equipped chemical laboratory for research work and for checking the steel purchased against specifications. This about-face practice of the consumer has done more to advance the progress of better steels and to develop a greater diversity of steels than the manufacturers' own initiative would have accomplished in double the time. Now, if one automobile manufacturer builds a car from steel containing molybdenum, and because of this steel produces a better car, his competitors must purchase a similar steel unless their research laboratories can specify a better one. Not many years ago the chemist was coaxing the steel industry; now he is driving it. The relationship has changed from servant to master.

In all probability, all growth and development in this great industry will be gradual, so far as basic methods of manufacture are concerned. An alloy can be added easily, but millions of dollars worth of equipment cannot be obsoleted over night. This would be a national calamity. Not many years ago this condition was approached when all the large customers began to specify steel made by the open-hearth process when most of the steel-making equipment was of the Bessemer converter process type. Chemistry again came to the rescue of the industry by demonstrating that with ore low in phosphorus and sulfur uniformly good steel could be made by the Bessemer process. All this ore was promptly located and reserved for smelting iron to be refined into steel by the Bessemer process. It was true better steel could be made by the open-hearth furnace, but a good and fairly uniform steel could likewise be made in the Bessemer converter. For such purposes as builders' hardware, farm fencing, and similar requirements, the latter method should be preferred because it is cheaper. The great problem in refining steel has been to eliminate most of the sulfur and phosphorus from the iron and add in the process the desired carbon and manganese or silicon. These elements could not be eliminated by blast or oxidation alone without the use of fluxes, which could not effectively be applied in the Bessemer process.

There could not be a better illustration of the aid of chemistry to an industry than the development of the iron and steel business in Alabama. It had long been known that geographically no other place on earth possessed, in such close proximity, all the necessary fuels, ores, and fluxes for making steel, but this knowledge had not been capitalized. This district was considered capable only of making cheap pig iron, good enough for castings but unfit for steel, due to the high per cent of phosphorus and sulfur in the iron. Iron containing a high per cent of phosphorus and sulfur could not be refined into steel by the Bessemer process, and this was the prevailing method until the early nineties when a noted

chemical engineer persuaded the Tennessee Coal, Iron, and Railroad Company to construct open-hearth furnaces and begin the manufacture of steel. The undertaking was discouraging and proved almost a financial disaster, due largely to the difficulty in eliminating enough of the phosphorus. Here again laboratory tests suggested the joint use of the Bessemer converter and the open hearth. This process, since known as the "Duplex Process," solved the problem. Steel comparable with the best straight open-hearth product has been produced ever since.

. When chemistry taught the steel industry how to remove phosphorus and sulfur from molten metal, by the addition of limestone in the furnace, the resultant slag was long considered a necessary evil and its disposal a considerable item of expense. The nearby roadbuilders used some slag for base and ballast, but the chemist discovered that by granulating the slag, he had a base for a high-grade cement. It has recently been discovered that slag produced from an Alabama open-hearth furnace, due to the excessive phosphorus in the iron refined, contains an average of 18% phosphoric acid, the residue, or balance, being pure lime. This discovery of the chemist has resulted in the establishment of a considerable fertilizer industry. In this same Alabama district considerable potash is being reclaimed from blast furnace flue dust and a substantial tonnage of nitrates in the form of ammonium sulfate is being produced as a by-product of coke manufacture. The chemist has thus developed as by-products of the steel industry three of the best known fertilizers—phosphoric acid, potash, and nitrates. One asks: 'What relation are these achievements of chemistry to the iron and steel industry?" The answer is that the cost of steel is reduced by the value of the fertilizers, and cost is the yardstick which measures the degree of success of any industry.

The American steel worker owes a deeper debt of gratitude for his high-wage standard to the chemist than to all the tariffs, bounties, and subsidies enacted by a kindly Congress, presumably to protect him.

Coke is an essential to the smelting of ores in a blast furnace, and approximately 85% of all coke manufactured in the United States is for that purpose; hence coke and its by-products are essentially a part of the iron and steel industry. The by-products of coke consist of many of our most valuable fuels and fertilizers as well as the famous coal-tar families of drugs and dyes, too numerous to mention. German chemists have done more to develop the recovery of by-products of coal than the American, but our steel industry was quick in availing itself of the cost benefits derived, when it was apparent that the by-products of coke had a market value about equal to the coke manufactured.

The achievements of the creative chemist in the iron and steel industry are so numerous and so closely related to the industry that to narrate

them would be a history of the advancement of the steel industry. As working partners they have made America the undisputed leader in this field of endeavor. They have supplied every domestic need, invaded the markets of the world at will, and secured for ourselves and allies a triumphant march to victory behind a barrage of steel that our enemies could not withstand and will not again wish to face. Chemistry and the iron and steel industry have proven our friends in need. They are brothers, indeed.

High Blood Pressure Reduced by Light.—The problem of high blood pressure has had light thrown on it in a most literal way by the experiments of Prof. C. I. Reed of Baylor University. If the results he has obtained with animals can be extended to apply to human beings, it may mean that this great curse of middle age will be lifted by nothing more difficult than scientifically applied sunbaths.

Prof. Reed began his experiments by shining powerful lights directly into the eyes of anesthetized animals, so that the beams would fall on the thick network of minute blood vessels lining them. The arterial blood pressure fell off rapidly in a short time, in some cases as much as 80 per cent. Then he repeated his experiment, this time throwing the light on the lining of the mouth, which is also rich in small blood vessels. Here also he obtained marked diminution of blood pressure. In both cases auxiliary experiments showed that no explanation could be found in theories of nervous effects of the light, or of chemical changes in the tissues caused by it.

As a final test, Dr. Reed placed his animals under anesthetics, severed arteries in their throats, and into the cut ends inserted quartz tubes, so that these tubes became a part of the animals' circulatory systems. Then he directed the light on the blood as it flowed through the tubes, and once more the marked lowering of the pressure was noted.

In none of the experiments, Dr. Reed stated, could the effects be traced to any special part of the light spectrum. In some of the tests he filtered out both the infrared and the ultra-violet rays, and in others he used all the radiation from his arc lamps; but in all cases his results were the same.—*Science Service*

New Diabetes Remedy May Replace Insulin.—Insulin, Dr. F. G. Banting's world-famous remedy for diabetes, the discovery of which won him a Nobel Prize, may be superseded within a few years in all but the most serious cases of the disease.

Another Canadian research worker, Dr. J. M. Rabinowitch, has prepared a substitute for it, which has the great advantage that it can be taken by the mouth. Insulin is administered by injections.

The substance which has been prepared by Dr. Rabinowitch is a sweet syrup, analogous to sugar, which is obtained from glycerin on which a certain bacterium has been allowed to act. It is known as dioxyacetone.

Dr. Rabinowitch, assisted by Miss A. B. Frith and Miss E. V. Bazin, gave dioxyacetone by the mouth to sufferers from diabetes in the Montreal General Hospital. It was found to have an admirable effect in lowering the blood sugar. It is expected to act as a perfectly efficient substitute for insulin in the future in most cases of diabetes where the disease has not advanced too far, so that in very many instances it will not be necessary to have recourse to the injections.

Dr. Rabinowitch is at present preparing a detailed record of the cases in which dioxyacetone has been used remedially.—*Science Service*

THE MODERN SOAP INDUSTRY

Part II

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Fillers
Soap Specialties
Shaving Soaps
Chemical Problems
Nature of Soap Solutions
The Colloidal Electrolyte Theory
Detergent Action of Soaps
Emulsifying Properties of Soap
Forms of Soap Solutions

In the preceding part of this paper a hasty sketch was given of the modern soap-making process and of the chief stocks now available to the industry, but little attention has been paid thus far to the crutching process. The crutcher is essentially a mixer, either mixing the soap with itself in order to improve its texture and appearance, or mixing it with some foreign material. Some of these materials are of actual benefit to the action of the soap; others merely add to its acceptibility to the public, without improving it; still others may be but inert fillers which add weight to the bar which one buys under the name of soap.

Fillers

In the first of the above classes we may group sodium carbonate, silicate and phosphate, borax, and a number of other substances such as naphtha and medicinals, even down to the sand and kieselguhr of scouring compounds. Both sodium carbonate and sodium silicate, perhaps more commonly known as soda ash and water glass, have considerable detergent power in themselves, the former due to its alkalinity, and the latter due to this cause as well as to innate properties which are as difficult to explain as are those of the soap itself. They both harden the soap and so make for economy in its use in the wash tub, and there is much washing that can be done by them more cheaply than by the more expensive soap itself. Sodium silicate in particular is valuable because it improves the appearance of the soap, and because it preserves the original whiteness of the clothes that are washed with it. Probably the greatest value of these two substances in soap, and of sodium phosphate as well, is in softening hard water. The hardness of water is commonly due to the presence of soluble calcium and magnesium salts. When soap is added there results the reaction represented by the equation

$$\underset{\text{Sodium soap}}{2C_{15}H_{31}COONa} + CaCl_2 \longrightarrow \underset{\text{Calcium soap}}{(C_{15}H_{31}COO)_2Ca} + 2NaCl \qquad (1)$$

The sodium soap unites with the hard constituents of the water to form the insoluble calcium and magnesium soaps, and these collect on the surface as a scum of no detergent value, and likely to form spots on the clothes. Thus no soap is available for washing until all of the hard mineral matter

has been eliminated. It is here that water softeners are of value. The carbonates, silicates, and phosphates of calcium and magnesium are all insoluble, and so if the soluble sodium carbonate, silicate, or phosphate is crutched into the soap the water softening will be done at least partially by these cheaper materials, according to the equation

$$Na_2CO_3 + CaCl_2 \longrightarrow CaCO_3 + 2NaCl \qquad (2)$$

rather than by the more expensive soap according to equation (1) given on the preceding page. Borax likewise has limited water-softening power.

Cutting table. After slabbing, the bars are cut by forcing through vertical wires or steel dies.

Naphtha soaps have become very popular, and a large proportion of the household laundry soaps sold in the United States today contains liquid hydrocarbons in amounts varying from a trace to 6% or slightly higher. The object of the incorporation of medicinals, such as phenols and sulfur, is, of course, evident, although their efficiency in such form has been questioned, and much of the value attributed to the medicinal is probably often due to the marked bactericidal power of soap itself.

As typical of the second class of ingredients added in the crutcher, namely, those which add to the attractiveness of soap without adding to its cleansing powers, perfumes and coloring matter may be mentioned.

The use of materials which can justly be classed in group three, namely, adulterants, is fortunately not frequently met with at the present time. Reference to the literature would indicate that there was a time when soaps were very commonly weighted with inert fillers; reference to chemical analyses of soaps now on the market indicates that at the present time competition has become so keen that the quality of the soap, if not the morals of the manufacturer, has been forced to higher levels. There are but rare instances now of the use of fillers whose sole purpose is to add weight or bulk to the bar, and the manufacturer who uses talc, starch, kaolin, mineral oils and the like, usually justifies himself on the ground that small amounts of these materials improve the appearance or texture or hardness or keeping qualities of his soap, and so make for it a readier market.

Soap Specialties

The staple products of the soap industry are the toilet, household, and laundry soaps, and also the textile soaps, used, for example, in scouring wool and de-gumming silk in the textile mills; but in addition to these there are numerous so-called "soap specialties" on the market. Thus transparent soap is a favorite with many for toilet use because of its attractive appearance. The desired transparency can be obtained in several ways, the most common being the use of a high percentage of castor oil soap, and the addition of sugar, glycerine, or alcohol. Alcohol is an excellent soap solvent, better than water itself, and by first dissolving the soap in alcohol and then removing the greater part of the alcohol by evaporation, a clear, transparent product results, free from the opaque fibers which crystallize out when aqueous solutions are concentrated and cooled.

Shaving Soaps

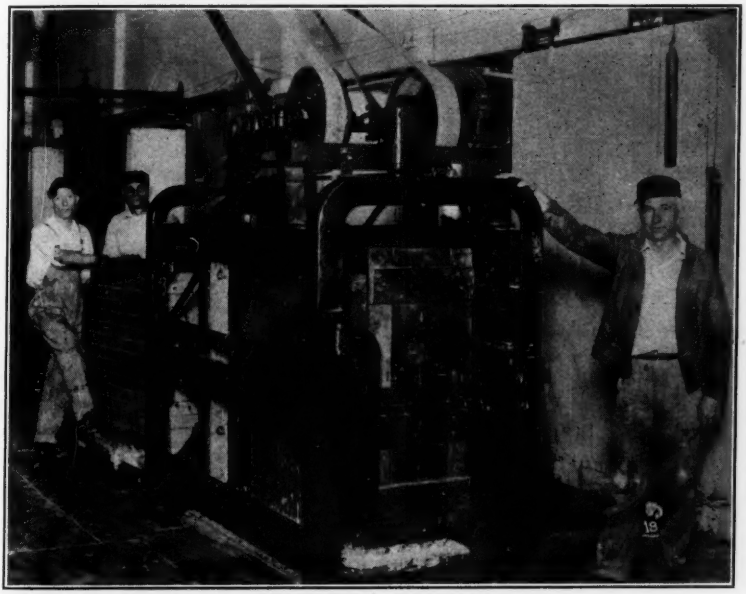
Shaving soaps are interesting, due to the specific properties required of them. They must lather very rapidly in both hot and cold water and the lather must be profuse, lasting, and non-drying; they must be non-irritating to the tenderest skin; softness is required of the shaving stick, even after aging and drying, and in the case of the paste, the consistency must remain the same in all seasons. In order that they may be soft and readily soluble, a mixture of the softer potassium soap with the harder sodium soap is common, the proportion of potassium being higher in the pastes than in the stick form. Potassium soaps alone are hardly acceptable, however, both because of their extreme softness and because of their peculiar reaction upon heating. Thus *heating* may make them *harder*, while *cooling softens* them, and the range of consistency may be too great for convenient use. In addition to using the soluble potassium soaps, the ability to work up a profuse lather in cold water is usually attained by the use of coconut oil. Large quantities of this constituent are excluded, however, because

of its irritating action upon the skin, its hardness, and its rather thin lather. In order to obtain a lasting, non-drying lather, tallow or commercial stearic acid is commonly used; and as a preventive of drying and because of its softening effect, glycerine is usually present in these soaps.

In liquid soaps much the same principles apply as in shaving soaps. Here also the very soluble potassium soap of coconut oil is of great value, alcohol or glycerine being often used to displace part of the water as a solvent.

Chemical Problems

The requirements of such soap specialties as these illustrate some of the problems that the soap chemist meets in his work. There is work for the



Slabbing machine. The frames are cut into slabs by forcing them through horizontal wires.

analytical chemist in the control of the raw materials used, and the character of the product at different stages; work for the organic chemist in the study of the fatty stocks and the relation of their composition to the resulting soap; work for the inorganic chemist because of the alkali hydroxides, silicates, carbonates, etc., used, and the ever-increasing demands of the hydrogenation process; work for the physical chemist in his examination of the finished product....What is a bar of soap? Is it a crystalline,

fibrous gel structure, enmeshing a liquid solution? What is the nature of the fibers? Is the soap hydrated with a definite amount of water of hydration, or is the water merely mechanically entrapped? What are the changes taking place as a soap sol sets to a gel? What is the condition of the soap when in so-called solution? Is it chiefly crystalloid or colloid? To what extent is it hydrolyzed, and what are the products of hydrolysis? Why do soap solutions foam? Why are they emulsifying agents? What is the explanation of their detergent power? These and a myriad other questions perplex and interest the colloidal chemist.

Nature of Soap Solutions

Probably the most fundamental of these questions is that of the true nature of aqueous soap solutions. The sodium salts of the lower fatty acids have no soap-like properties, and dissolve in water as true molecular solutions, dissociating into ions as do other salts. With caproic acid, C_6, there is a faint trace of soap-like properties; for example, a slight, transient foam appears in concentrated cold solutions. This is thought by many to mean that some soap is present in colloidal form, but that as the solution is diluted, or as the temperature is raised, the colloidal aggregates break up into their constituent molecules; that is, the colloid-crystalloid equilibrium is shifted toward the crystalloid form, and the foaming ceases. With caprylic and caprie acids, C_8 and C_{10}, the soap-like properties become more marked, but it is lauric acid, C_{12}, that furnishes the first really good soap. Sodium laurate is very soluble and lathers freely in cold water, but as the temperature rises, the colloidal particles presumably become more crystalloidal, and the lathering decreases. Sodium myristate and palmitate, C_{14} and C_{16}, are less soluble, but they are "soaps" at high temperatures as well as low, in dilute solutions as well as concentrated. In other words, high temperature and great dilution do not cause the colloidal particles of these soaps to dissolve in molecular form. As the laurate marks the first good soap of this series, so the stearate, C_{18}, marks the last. Even at high temperatures and low concentration its solutions are colloidal and form a lather, but it is so slightly soluble that in cold water it is of little value. When its solutions are cooled, the stearate is thrown out of solution and opaque fibers form, the solution becoming thick and cloudy, and finally setting to a gel.

Probably the simplest explanation of these phenomena is that of a crystalloid-colloid equilibrium. Soap solutions in alcohol are clear and limpid, even at high concentrations, but they have no lathering power; they are probably true solutions, while the colloidal nature of the aqueous solutions is shown in numerous ways. Thus crystalloidal matter passes through the fine pores of an ultra-filter, while the larger colloidal particles are held back. Determinations of the amount of soap passing through the filter affords

therefore a quantitative measurement of the amount of crystalloidal matter present, as do also osmotic pressure measurements, since crystalloids exert osmotic pressure while colloids do not. Although direct osmotic pressure measurements are difficult, McBain's study of vapor pressure by means of his "dew point" method affords fairly accurate data which serve much the same purpose.

The Colloidal Electrolyte Theory

As a result of his studies of the conductivity, osmotic pressure, and colloidal behavior of soap solutions, McBain has arrived at the most com-

Stamping machine. After cutting to size the bars are stamped under pressure.

prehensive theory of their constitution that has yet been advanced. This is the theory of colloidal electrolytes and the ionic micelle, and is, in brief, as follows:

The osmotic pressure of soap solutions is moderate, being about half that of a salt; the conductivity is high, being equal to that of a salt. It follows that half the conductivity must be due to electrically charged particles which do *not* exert osmotic pressure, and that are, therefore, colloidal. These constitute the ionic micelle, which are pictured as aggregations of ordinary negative fatty acid ions which have combined with a number of water molecules and with neutral colloidal soap particles. The whole

collection thus constitutes one large electrically charged colloidal particle, having the composition $(NaR)_x(R^-)_y(H_2O)_z$, where R is a fatty acid radical. Colloidal electrolytes are substances which are capable of giving ionic micelles like the above; they are electrolytes because they dissociate into current-bearing particles, and they are colloidal because some of the products of dissociation combine in aggregates of colloidal size. On the basis of a reversible equilibrium between soap molecules, neutral soap colloid and the ionic micelle, McBain accounts for many of the phenomena observed in soap solutions.

The same author has also shown that hydrolysis of soap solutions is of but little importance except when the dilution is great, since in ordinary solutions the hydroxyl-ion concentration is only about $0.001N$. Prior to this work there had been much uncertainty as to both the degree of hydrolysis and the nature of the products resulting from it. McBain's results indicate that only minute traces of free acid are ever formed, and that instead an acid soap is present, ranging in composition between NaR and $NaHR_2$.

Detergent Action of Soaps

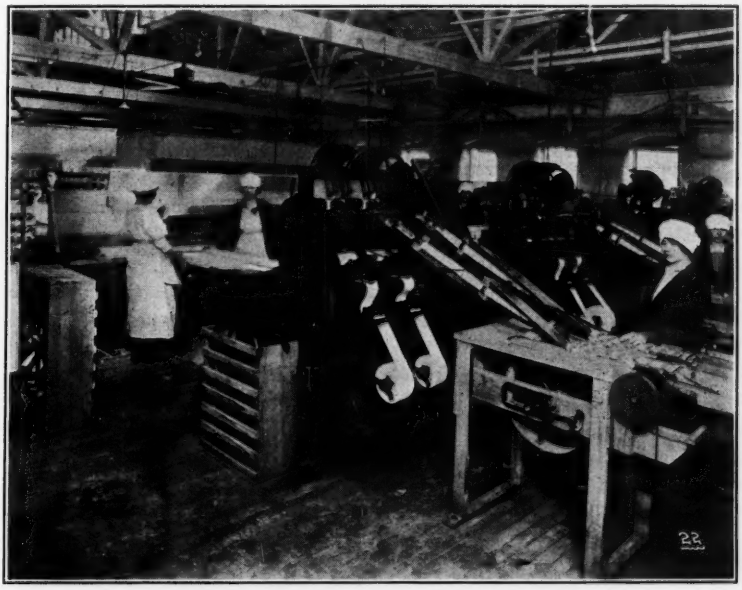
Many attempts have been made to explain the detergent action of soap. One of the earliest, largely abandoned now, was the theory that the hydrolysis of the soap is extensive, and that the alkali set free saponifies the greasy part of the dirt. The coating around the solid particles being thus removed, the particles themselves can easily be washed away. It is difficult, however, to explain why the alkali should combine with the grease which is saponifiable with difficulty, rather than with the fatty acid from which it came, or why rapid washing is possible in cold water, while saponification of neutral fat is extremely slow even at 100°. The work of McBain just referred to shows the OH-ion concentration to be far too small to cause appreciable saponification.

The surface tension of a soap solution is extremely low, and as a result it can penetrate into minute crevices. Soap solutions also have the power of wetting almost any kind of material, and so having penetrated between the cloth fibers and wet them, the soap may serve as a lubricant for the dirt particles and thus facilitate their removal by rubbing. According to Pickering, the soap dissolves the coating of grease which surrounds solid dirt particles, and thus frees them; while Hillyer thinks that washing may be due chiefly to the emulsification of the grease. Spring holds that too much attention has been paid to grease and oil in all explanations of washing, and he shows that with non-greasy lamp-black it is likely that colloidal acid-soap particles form adsorption compounds with the carbon particles as a result of the difference in sign between the electrical charges of the soap colloid and the carbon. According to this theory, alcoholic soap

solutions do not cleanse because no hydrolysis of the soap occurs in this case; there is therefore no acid-soap present, and so no adsorption occurs. In all soap solutions there is an optimum concentration above and below which the washing power of the soap decreases; this must be the particular concentration at which there is present a maximum number of acid-soap particles.

Emulsifying Properties of Soap

Closely allied to the detergent power of soap is its ability to foam and to emulsify oils. Why is it possible to blow bubbles from a soap solution



Wrapping machine. The wrapping process is entirely mechanical.

and not from pure water or from a sugar solution? Several workers have shown that even in very dilute solutions of almost all soaps the surface layer is many times more viscous than is the liquid of the interior. The bubble film is similar to such a surface layer, and since high viscosity would oppose the draining of the liquid down the sides of the bubble, we should expect that the more viscous the film the more permanent it should be. Yet sodium oleate, which is peculiar in having a surface viscosity practically the same as that of water, is an excellent foamer. The same objection holds against the theory of R. E. Wilson, that the bubble film is a plastic soap gel, which would naturally possess some rigidity, and would not

drain down from the top of the bubble. A somewhat similar theory is based upon high elasticity of the surface layer, as a result of which a thin bubble film could adjust itself to shocks and strains.

Such phenomena as a special surface viscosity or elasticity follow from the fact that soap lowers the surface tension of the water, and therefore concentrates in the surface. Aside from any special surface concentration, however, the low surface tension of soap solutions is undoubtedly one of the important factors giving them lathering power. Surface tension operates to tear a film apart and disrupt it, so that low surface tension would naturally be expected to go with high foam power. To a large extent this is true; yet the foam power of soap solutions may vary widely upon aging, while the surface tension remains constant at a low value. The whole question of lathering affords an interesting field for research.

Intimately associated with lathering power is emulsifying power. It is almost impossible to form an emulsion of oil in pure water, but upon the addition of a little soap emulsification becomes easy. In this case, as in the air emulsion which we call lather, interesting application can be made of the theory of the oriented surface molecule, as put forth by Langmuir and Harkins. According to such a theory, in an oil-in-water emulsion stabilized by soap, the oil droplet is probably completely surrounded by soap molecules, which concentrate in the oil-water boundary, and form a protective skin or pellicle about the oil. Thus with sodium palmitate, $C_{15}H_{33}COONa$, the long hydrocarbon chain $C_{15}H_{33}$ has a much greater affinity for oil than for water, while the reverse is true of the COONa part of the molecule, which is highly soluble in water. If we think of the molecules as being long and slender, with one end oil-soluble and the other end water-soluble, we should expect them to collect at the boundary between oil and water, and form an oriented layer there, with the $C_{15}H_{33}$ end sticking in the oil, and the COONa end in the water. The oil droplets, thus surrounded by a layer of soap, are kept from coalescing, and the emulsion is therefore permanent. So also with an air emulsion, we may have a concentrated surface layer with the COONa part of the molecule dissolved in the water of the bubble film, and the hydrocarbon chain erect, pointing into the air. Such a structure of the bubble might account for its stability. Instead of individual soap molecules, it may be that larger aggregates of colloidal size form the protective coating about the emulsified oil droplet, and this might perhaps be true of Spring's carbon-black as well.

Forms of Soap Solutions

Microscopic and ultra-microscopic examinations with both ordinary light and polarized light have within recent years revealed much as to the structure of soaps, while leaving unanswered many questions of both theoretical and practical importance. According to McBain, soap occurs

in five chief forms. Whenever all the soap is in solution, whether colloidal or molecular, it is clear and transparent. In this state it may be (1) a fluid sol, (2) a clear elastic gel, or (3) a clear crystalline liquid. When solid matter separates from the solution, we have the fourth and fifth forms which the soap may take, namely, curd fibers and true crystals.

The only difference between sol and gel which McBain has been able to detect is the mechanical rigidity and elasticity of the latter, and he considers the colloidal particles in the two forms to be identical both in kind and amount. The detergent action of soap is practically confined to the fluid sol state, however. The structure of the gel is still unknown, but it is probably filamentous. The "brush-heap" idea is attractive—that of long filaments piled up like a brush-heap, enmeshing liquid solution in the spaces. The crystalline liquid form of soap occurs in the most concentrated solutions, or in those to which much salt has been added. It is immiscible with the other forms of soap, but, unfortunately, the anisotropic liquid crystals have not yet been thoroughly investigated. True solid soap crystals are much more common with potassium than with sodium soaps. The usual solid form in which sodium soaps appear is that of white curd fibers. Under the ultra-microscope the formation of a soap curd can be seen to be due to the separation from solution of microscopic or ultra-microscopic fibers of neutral soap. The ordinary commercial soap in bar form is thought to be made up of such fibers, enmeshing a sol or gel of more soluble soaps.

Such are but a few of the many theoretical considerations which have a vital bearing upon the soap industry. The limits of space prevent discussing them more fully, yet it is hoped that enough has been given to show something of the magnitude of the field of soap chemistry—a field whose borders, only, have yet been cultivated, and whose untouched interior offers fertile soil for chemical research.

Helium Chemist Gets Perkin Medal. The Perkin Medal for 1925, one of the highest awards in chemistry, has been awarded to Dr. R. B. Moore, formerly chief chemist of the U. S. Bureau of Mines and largely responsible for the development of helium production during the war. The medal is given by the American section of the Society for Chemical Industry and the selection is made by a committee from that organization, the American Chemical Society, the American Institute of Chemical Engineers, and the American section of the Societe de Chimie Industrielle. The presentation will be made January 15.—*Science Service*

To give the human spirit freedom, to make it more fully alive, is undoubtedly the great dominating purpose for which our colleges exist.

—JAS. R. ANGELL, President of Yale University

THE LIFE AND CHEMICAL SERVICES OF FREDRICK ACCUM

CHARLES ALBERT BROWNE, CHIEF, BUREAU OF CHEMISTRY, WASHINGTON, D. C.

Chapter V

Unfortunate Ending of Accum's Career in London

Accum had now attained the very height of his celebrity. His reputation as a public lecturer, chemical expert, and author had made him one of the best-known men in Great Britain, while the publication of his numerous books in America, France, Germany, and Italy gave him no small amount of international fame. In his efforts to popularize chemistry and to bring it home to all classes of people, Accum had made his name known in every intelligent household. The extent of his public reputation was recognized by no less a periodical than the *European Magazine*, which published in the summer of 1820 a biographical sketch of Accum with an engraving of his portrait made by Thomson from a painting by Drummond. Accum's activities as teacher, author, technical expert, and dealer in apparatus and chemicals had become very remunerative and no chemist living at this time appears to have been more comfortably or permanently established than he. Yet it was the misfortune of this unhappy man within a single month to witness the loss of reputation, business, and friends.

The work of the reformer in all ages has been rewarded with hatred and abuse; this is as true of those who strive to prevent the adulteration of foods as it is of those who seek to abolish other evils. Recent events in the history of the pure-food movement in modern times are a simple repetition of what happened one hundred years ago to Accum. From being one of the most popular men in London, he awoke one morning to find himself one of the most deeply hated. His publication of the names of merchants and manufacturers, among them men of wealth and prominence, who had been guilty of food adulteration, was largely responsible for this. The rising storm of abuse simply strengthened, however, his original purpose which he once more proclaimed in the second edition of his treatise on food adulteration in April, 1820.

> To those who have chosen anonymously to transmit to me their opinion concerning this book, together with their maledictions, I have little to say; but they may rest assured, that their menaces will in no way prevent me from endeavoring to put the unwary on their guard against the frauds of dishonest men, wherever they may originate; and those assailants in ambush are hereby informed, that in every succeeding edition of the work, I shall continue to hand down to posterity the infamy which justly attaches to the knaves and dishonest dealers who have been convicted at the bar of the Public Justice of rendering human food deleterious to health.

These were brave words but the secret enemies of our author were more powerful than he imagined. If anonymous letters could not accomplish

their purpose, there were other more effective weapons. The reformer of all men should be most free from any lapses in the moral code and Accum, unfortunately, was not altogether blameless in this respect. Certain indiscretions of conduct made him an easy prey to the attacks of his enemies and before the end of 1820 he fell a victim of one of the worst scandals in which it was ever the lot of a man of science to become involved.

Mention has been made of Accum's connection with the Royal Institution where he was at one time chemical operator and to the managers of which he dedicated his first book on chemistry. After his resignation as chemical operator, Accum continued to remain a subscribing member of the Institution, which was only a short distance from his residence in Old Compton Street. He attended its meetings and in the evening, after his day's work, had frequent occasion to consult its books of which at one time he had been appointed a librarian.

Only a few months after Accum's challenge to his anonymous enemies, a complaint was made by an assistant to the managers of the Royal Institution that Accum was secretly mutilating the books of its valuable library by tearing out part of their leaves. It was stated that this practice had been carried on for several years, but only recent happenings seemed to indicate Accum as the guilty party. The managers were at first inclined to ignore the charge, but on further complaints the librarian of the Institution on December 21, 1820, went to Accum's house with a search warrant and two officers. Accum was naturally surprised when the officers stated the object of their business and while his desk and papers were being ransacked walked up and down the room in great agitation. Some thirty or more stray leaves were found which the librarian said belonged without doubt to books of the Royal Institution. Accum was accordingly arrested and brought before a magistrate upon the charge of robbery.

The magistrate who tried the case was evidently a humorist. After hearing all the evidence, he delivered the opinion that "however valuable the books might be from which the leaves found in the prisoner's house had been taken, yet the leaves separated from them were only waste paper. If they had weighed a pound, he would have committed him for the value of a pound of waste-paper, but as that was not the case he discharged him."

That the magistrate regarded the charges against Accum as baseless is evident from the ridiculous technicality on which he dismissed the case. The managers of the Royal Institution were disposed, however, to take a different view and accordingly brought an indictment against Accum upon the charge of mutilating books. The case was set for trial in April, 1821, Accum meanwhile being released upon bail.

For a person of such prominence as Accum to be indicted by the Royal Institution naturally gave rise to considerable clamor and discussion.

Accum's enemies were prompt to seize the opportunity and revenged themselves by giving the unfortunate affair all possible publicity. He was sneered at in the newspapers and lampooned by the punsters. The following verse, called "Death in the Pot," printed first in a paper called *John Bull*, was given wide circulation:

What is his crime? A trick at most
A thing not worth debating.
'Tis only what the *Morning Post*
Would call *Accum*-ulating.

Public opinion under the influence of the prejudice which had been aroused turned strongly against Accum. Doors, which before had always been open, were now closed to his entrance. Even Accum's publishers, who had reaped so rich a harvest from the sale of his books, went over to his enemies. Accum, as a popularizer of chemistry, had become to the people of London almost an institution. As Silliman once stated, "he was to the Londoners a pet chemist" and the reaction of opinion against him was all the more bitter for this reason.

Unfortunately for Accum certain peculiarities of character made it difficult for him to establish his innocence. His defense that the leaves seized by the officers at his house belonged to books which he had at home, was ridiculed as absurd, for what person could be so senseless as to mutilate his own library. But those who knew Accum were aware that he was singularly indifferent in the treatment of his own books and never hesitated to despoil them of leaves if it suited his convenience. Some of his friends believed that, in the almost childish simplicity of his character, he would treat the books of other people in a similar way without any intention or consciousness of wrong doing. To others it seemed as if some cunning enemy, with full knowledge of Accum's habits, might have absconded leaves from the library of the Royal Institution and secreted them among his books and papers; but such a conspiracy, however probable, could not be proved. The best that Accum's friends could do was to make an appeal to the managers of the Royal Institution to withdraw their case. The following remarkable public letter in the *London Times* of January 10, 1821, written without doubt by Accum's early friend Sir Anthony Carlisle, is worth reproducing as it seems to offer the most reliable means of forming an opinion of the case.

To the Right Hon., The Earl Spencer
London, Jan. 8, 1821.

My Lord: Your high rank, talents, literary possessions and undisputed honour may command a degree of attention to this appeal which its writer could not otherwise expect.

As President of the Royal Institution founded for the promotion of science, your rightful influence in all its affairs cannot be doubted; and I accordingly beg leave to submit to your Lordship's just and liberal consideration the case of a man of science now

under its prosecution. Mr. Accum is the person on whose behalf I address your Lordship; his merits as a chymical operator and as a remarkably ingenious man must have been often exhibited to your Lordship in the practical works of the Royal Institution. His native simplicity, his lively intelligence and the frankness with which he exposes his extensive knowledge to every inquirer have introduced him into companies to which his early condition in life gave him no pretensions. From your Lordship's urbanity and attachment to letters, I anticipate your pardon in attempting this public apology for an unfortunate. I have been his first friend and perhaps the humble means of leading him into many of the situations which he has hitherto filled with credit and, I may venture to add, with some benefit to science and the useful arts. From a knowledge of Mr. Accum's character, I am aware of his inability to make a competent apology for himself and I am also convinced that the misconduct of which he is accused never appeared to his mind with the same moral turpitude as it does to men of more refined education, or to those whose early habits and examples have been calculated to imbue them with notions of honour.

I do not seek to palliate the gross misconduct or the public injury attached to the crime of which he stands accused, nor can I doubt of its being justly fixed upon this ill-fated man; because from an acquaintance with his habits I know the alleged misconduct to be the same as he would adopt in his own library and what he constantly practices among the materials and utensils of his laboratory. He was brought up to witness a similar kind of destructive waste by the late celebrated Mr. W. Nicholson, whose zeal for science and heedlessness as to the value of literary materials made him tear up books and destroy expensive apparatus to save time and trouble without bestowing a thought on the ruin he committed. I am confident that Mr. Accum and Mr. Nicholson have never estimated books beyond their crucibles or even the coals to be consumed in their experiments. With them a printed volume was considered in the abstract as a mere vehicle of knowledge and its destruction, like that of a pot or a pan, rather beneficial to trade than a venial offence. Trusting to your Lordship's high-minded charity for the infirmities of men not blessed with early, habitual, and exemplary patterns of honourable integrity, I solicit your magnanimous interference to stop further proceedings against Mr. Accum. Surely the justice of this case is already appeased from the extremely harsh measures adopted by his prosecutors and I cannot believe that your Lordship would lend your countenance to *persecution* against a man of science even if his conduct had been more criminal.

This terrible example is enough to prevent men of slovenly morals from trespasses of this kind and I humbly observe that if the same misconduct had through inadvertence been detected in other gentlemen belonging to the Royal Institution whose origin and education have not been above that of the party now accused, they would have found many apologists more potent than your Lordship's present addresser and your Lordship's most respectful and humble servant.

A. C.

This sad affair, into which was injected an incredible amount of animus and hate, had a most depressing influence upon Accum. He was by nature intensely fond of popularity and the sudden loss of the favorable public opinion, which he had so long enjoyed, had its inevitable result. He fell at once into a condition of despair which the efforts of his friends could not dispel. His tireless energy, which might have helped to create a reaction, gave way to a state of lethargy and melancholy. He no longer interested himself in chemical work and did not even take account of his approaching

trial. On the fifth of April, when the case of the King *vs.* Accum was called, the defendant failed to appear. His bail was accordingly forfeited, although the reservation was made that in case he should appear for trial during that session of the court, his recognizances might be saved.

Such was the unfortunate end of Accum's long and useful career in England and it seems a pity for we know that he had plans in view for many fields of service. There was, however, one final work which Accum was prevailed upon to accomplish and that was the completion of his little book on "Culinary Chemistry" which was brought out by his friend Rudolph Ackermann, the art publisher, whose reasons for printing the book deserve to be recorded.

> I feel it in some measure incumbent on me to explain the cause of my having undertaken to be the publisher of this volume. It has arisen from a distressing event, in which its very ingenious, useful, and elaborate author happened to be involved. The work was in some degree of advancement when the sudden and unexpected misfortune, to which I have alluded, threw him at once into a state of discouragement that gave a check to all his exertions. I, who had known him long, and had every reason from a most intimate acquaintance to think well of him both in his private as well as professional character, coöperated with many of his friends, some of whom are in the superior rank of life, to encourage him in the renewal of his former energy—but I could succeed no further than in prevailing upon him to complete this little work on Culinary Philosophy, which promised to be highly useful in some of the leading objects of Domestic Economy. When it was ready for publication the prejudice which had been excited against him, rendered his former publisher averse from presenting it to the public. I, therefore, felt myself under a kind of undispensable engagement—nor am I ashamed of it, as the work was brought to a state of publication by my interference though out of my usual line of business—to become its publisher. I accordingly under these circumstances made it my own by purchasing the copyright.

All credit be to Ackermann for having saved this little work on Culinary Chemistry from oblivion! Its value, in respect to those intangible benefits of improved health and domestic comfort, can never be estimated. A copy of the book in the author's possession bears a Christmas inscription for 1856 and we see in this, as in so many other instances, how long and how extensive a popularity the writings of Accum enjoyed.

Chapter VI

Last Years as Professor in Berlin

The few remaining months of Accum's residence in London were spent in settling up his affairs. As soon as this was accomplished, he bade farewell to England and returned to his native country. For a man fifty-two years of age to sever the connections of thirty years and begin life anew in another land might seem a doubtful venture. Yet when we consider the extent and depth of the prejudice which Accum's enemies had aroused against him, it was no doubt the part of expediency to leave England.

There was probably no place in Germany better suited to restore the depressed spirits of a scientist than the famous establishment of Gottlob Nathusius at Alt-Haldensleben, where Accum first went to spend a short period of rest. Nathusius, after acquiring considerable wealth in business, had retired to a large estate at Alt-Haldensleben where he instituted an industrial colony for conducting technical and economic experiments upon an extensive scale. Factories were erected for making flour, sugar, oil, wine, beer, spirits, vinegar, tile, brick, porcelain, and other commodities, while the grounds of his property were beautified with orchards, conservatories, gardens, and parks. Nathusius had also collected a choice library and had equipped a fine laboratory where chemists were employed in various problems of research. The establishment became in consequence a great center of culture, to which visitors were attracted from all parts of Europe.

The chemical and industrial operations at Alt-Haldensleben had naturally a great interest for Accum. When he was not occupied with these scientific attractions, his time was free either to enjoy the society of his hospitable friend or to walk through the grounds of the beautiful estate.

After a short stay with Nathusius, Accum proceeded to Berlin where he accepted in 1822 a dual position as Professor of Technical Chemistry and Mineralogy at the Royal Industrial Institute (*Gewerbe-Institut*) and as Professor of Physics, Chemistry, and Mineralogy at the Royal Academy of Construction (*Bau Akademie*). In connection with his work at the latter school he published in 1826 at Berlin the one book which he wrote in German—his "Physische und Chemische Beschaffenheit der Baumaterialien, deren Wahl, Verhalten und Zweckmässige Anwendung." This was the last work from Accum's pen and the final evidence of his former marvelous energy.

Accum's purpose in writing his work on the physical and chemical properties of building materials was first to provide a hand-book for the convenience of students at the Berlin Academy of Construction and second to supply a treatise for the practical use of architects, carpenters, and masons. The general scheme and method of treatment which the author adopts are excellent and the book, with the addition of modern illustrative material, might still serve as a model of its kind. The subject-matter is arranged under the seven general headings of Earth, Wood, Stone and Brick, Cement and Mortar, Metals, Paint, and Glass. Under each heading are given the physical and chemical properties which make various products suited or unsuited for building purposes; the valuation of materials; qualities that insure stability and durability; selection of the best materials for foundations, walls, chimneys, and roofs; method of determining rigidity, resistance to fracture, hardness, tensile strength, etc.; and tables of physical properties. The chemistry of decay, weathering, fire-

proofing, rust prevention, setting of cement and the efflorescence of salts which appear on the surface of masonry are a few of the many interesting topics on which the author throws the light of his extensive practical knowledge.

For the convenience of his students in reviewing the subject the text of the book is interspersed with brief references in fine print to points which were elaborated more fully in his lectures, such as the mention of experiments, exhibits, illustrations, specimens, and anecdotes, while here and there to draw out the mind of the reader a pertinent question is asked. All of Accum's contemporaries speak of his ability as a lecturer and public demonstrator and these scattered lecture hints give one an idea of the varied methods by which he kept alive the interest of his students. The practical trend of Accum's method of instruction is shown on nearly every page of his last treatise on the properties of building materials.

Accum during his residence in London had become connected with several learned societies. He was a subscriber to the Royal Institution, a member of the Royal Irish Academy, a fellow of the Linnean Society and a corresponding member of the Royal Academy of Sciences in Berlin. His connection with the latter society was naturally retained after his return to Germany. Among its corresponding members during Accum's Berlin residence, we note the names of such famous chemists as Chevreul, Dalton, Dulong, Dumas, Gay-Lussac, Liebig, Thenard, and Wöhler. It was a period of most active research in chemistry, but Accum in his old age remained only an interested spectator of the new developments; his own life-work had been accomplished. He still continued, however, his professional duties as a respected member of the faculties of the Berlin Industrial Institute and Academy of Construction until his death on June 28, 1838.

Such was the career of one of the most interesting figures in the chemical world of one hundred years ago. Unhappily for Accum, his fame, when at its fullest, underwent an eclipse from which it never afterwards emerged. The unfortunate cloud which obscured his reputation caused many contemporary writers to avoid mention of his name and in the course of years he came to be forgotten. The desire to obliterate Accum's name from public notice is revealed in the attitude of one of his former publishers who in reprinting his dictionary of chemical apparatus in 1824 omitted the author's name from the title page. Accum himself seems to have accepted the situation and to avoid stirring up hostile memories published the articles which he wrote in later years either anonymously or under the reversed letters that form the pseudonym Mucca.

The enemies of Accum were successful in their attempt to drive him from England, with the result that the adulteration of food in that country went on unmolested for another thirty years. The work which Accum

could not accomplish unaided was finally taken up again in 1851 by Dr. Hassal who, with the support of the Analytical Sanitary Commission, made a most rigorous series of investigations and, following once more the hazardous example of his predecessor, published broadcast the names of firms who sold impure or adulterated goods. This work of Dr. Hassal led finally to the passage of the Adulteration Act of 1860, which is the pattern of all modern pure-food legislation. Thus after an interval of forty years the work of the man who began the first crusade against food adulteration was brought to a successful conclusion.

While Accum made no important discoveries in pure chemistry, and in this respect was over-shadowed by Davy, Wollaston, and others of his London contemporaries, he did most effective work as a teacher and promulgator of the new ideas. He aimed to popularize chemistry and in this he was preëminently successful for he brought it home, so to speak, not only to noblemen but to men in every other walk of life. Accum also deserves to be remembered by American chemists, for his establishment in Old Compton Street, London, was the first European school in which students from the United States could, and did, receive practical laboratory instruction.

As a technical chemist, Accum was gifted with great foresight as to the importance which chemistry was to achieve in various branches of industry. He was the first, as we have seen, to bring that new commodity, beet-sugar, to the attention of the English people and the earliest to experiment upon the practical utilization of the distillate from coal tar. He was also the first chemist to foresee the possibilities of the new coal-gas industry. He did more than any other chemist of his day to free the public mind from its prejudice against one of the greatest of municipal improvements. "*Ex fumo dare lucem*" was the quotation from Horace, which, in its double significance, he aptly chose as a motto of that first "Treatise on Gas Light."

No attempt has been made in this narrative either to conceal or to excuse the faults of Accum. These faults, however, were the result of thoughtlessness, or neglect, and not of natural depravity. The haste with which he worked and the variety of his activities caused him at times to become careless; he also had the reputation on occasions of driving a sharp bargain in his business dealings. His fondness for publicity led him to adopt methods which more sober-minded scientists regarded as sensational. On the other hand, his contemporaries spoke admiringly of his frankness, ingenuity, energy, and generosity. The natural zeal, vivacity, industry, and shrewdness of his French and Jewish ancestry were blended in him to a peculiar degree. He was a man who loved chemistry and his fellow chemists and for the purpose of serving his friends was ready, as Silliman said, to go "to the end of the earth." All things considered, he was one of the most unique figures in the history of chemistry.

It is a pleasure to note that chemists are coming to a more just estimation of the character and work of Accum. In this connection the following opinion of Prof. W. J. A. Butterfield in his "Lectures on Chemistry in Gas Works" is quoted:

> I cannot but feel that someone blundered badly in bringing a charge of petty theft against a man of Accum's position and attainments. His very numerous works on scientific and technical subjects, nearly all of which passed through more than one English edition and were translated into other languages, make it clear that in the bare thirty years which he spent in England he did more to spread a knowledge of chemistry and to further the application of chemistry to the arts and industry than many whose names are better known to fame in the same connection. The gas industry is indebted to his work and writings for the prompt adoption in the second decade of the nineteenth century of gas-lighting in London and other large cities.

The relentless pressure of criminal charges against Accum seems at the present day to have been indeed a blunder. But, however we may view the act itself of which Accum stood accused, we can see only too plainly, in the prejudice and hatred which were excited against him, the efforts of a strong band of enemies to work the undoing of the man who uncovered the secrets of their fraudulent business and exposed their names to everlasting infamy. As Accum's friend and apologist, Sir Anthony Carlisle, has intimated, if the charge of mutilating books had been brought against any other member of the Royal Institution, a private adjustment of the matter could no doubt have been arranged and the disgrace of a public scandal prevented.

In view of the services which they rendered to science and humanity, the world regards lightly the misanthropic habits of a Cavendish, or the petty jealousy of a Davy. As Benjamin Silliman, senior, once wrote—"Alas for human weakness! When, in July 1851, I stood by the grave of Davy in the public cemetery of Geneva, I forgot his follies and remembered only his virtues and his brilliant success and service to mankind." Let us be equally charitable to the memory of Fredrick Accum.

In preparing the present account of the life and chemical services of Fredrick Accum, the author has consulted various English and German dictionaries of biography, but for most of his information he has gone back so far as possible to contemporary sources. This sketch was begun in 1915, but its publication was postponed until certain facts pertaining to Accum's parentage and early life could be determined. This information has since been very kindly supplied by Burgermeister Wiehe, Professor Koch (Studienrat of the Gymnasium Adolfinum), and Hofprediger Müller, of Bückeburg, Germany—to all of whom the author desires

to express his appreciation for their friendly assistance and collaboration. Unfortunately, there are still existing certain lacunae concerning Accum's family and the last years of his residence in Berlin; the filling in of these gaps must be left for those who have more immediate access to existing records. It is hoped that the phases of Accum's life which are presented in these pages may stimulate others to investigate the career of one of the most interesting chemical characters of a century ago.

The author in conclusion wishes to express his indebtedness to Mr. N. C. Rockwood, of Napiersville, Illinois, for lending him various documents that belonged to his great-grandfather, Prof. William Peck, of Harvard College; to Mr. Andrew Keogh, Librarian of Yale University, for the privilege of consulting manuscript diaries of Prof. Benjamin Silliman, Sr.; to Mr. J. C. Ogilvie, F. C. S., of London, for a photograph of Accum's old laboratory building; and to Prof. Edgar F. Smith, of Philadelphia, whose review of the manuscript and kindly advice have been of the greatest assistance in preparing this work for publication.

Tuberculosis Vaccine Tried on African Apes.—A series of experiments, continuing the efforts of years to find an effective vaccine against tuberculosis, are being carried out in tropical West Africa on the manlike apes. Dr. J. Wilbert, who has announced promising results for the Pasteur Institute, does not, however, venture to say how these may lead to the ultimate goal, anti-tuberculosis vaccination in man.

The experiments carry on the pre-war work of Dr. A. Calmette and C. Guerin, who produced a vaccine of tuberculosis organisms greatly reduced in virulence, which, they have repeatedly claimed, confers immunity without giving the disease. According to Calmette, the only effect of vaccination with this serum is to produce a "general disease like typhoid fever which cures itself spontaneously after fifteen to twenty days without causing the slightest tubercle formation."

Calves, guinea pigs, rabbits, and monkeys treated with a small dose of the substance, he stated, appear to become highly resistant to tuberculosis. The war caused a postponement of his attempt to carry the experiments further by trying the serum on man's nearest biological relation.

Human conditions were reproduced as far as possible in the ape colony. Fifty-nine chimpanzees lived under similar conditions of exposure. Nineteen were vaccinated, twenty were infected with virulent tuberculosis germs and twenty were kept unvaccinated as control animals whereby to judge the rest.

Of the nineteen vaccinated, eleven died of various causes but never showed any sign of tuberculosis even at death, and the other eight are now in good health. Of the twenty unvaccinated animals kept as controls, nineteen died of tuberculosis and the other of an acute infection of another kind. Of the twenty animals infected with virulent tuberculosis, nineteen died of the disease and the other of intestinal trouble. Thus out of fifty-nine apes, only eight are now alive and all of these had been vaccinated.
—*Science Service*

COURT OF CHEMICAL ACHIEVEMENT, TENTH EXPOSITION OF CHEMICAL INDUSTRIES

PROTEINS FROM BEEF BLOOD

AMERICAN PROTEIN CORPORATION, BOSTON, MASS.

Blood is usually regarded as a waste product to be rendered into fertilizer or glue. A large amount of blood is drawn from animals slaughtered for food purposes. These animals are inspected by a Government service and only healthy animals are passed for food for human consumption. The blood of healthy animals is clean and has food value.

The conservation of this material and its preparation in such form that it will serve as a useful food constituent has been the aim of the development work of the American Protein Corporation. The principal protein products offered at present are Blood Albumin and Hemoglobin. These products are furnished as dry water-soluble powders, or as concentrated solutions. Fibrin is one of the by-products.

The use of blood as a food substance has been advocated from time to time. Blood sausage is well known, especially in central Europe. In Germany its use has been suggested in sauces and soups and various other ways, but the actual adoption of blood as an article for food for human beings has not been widespread. There has been a prejudice on the part of civilized peoples against the consumption of red blood. Although the logical reason for this cannot be readily formulated, it seems a natural prejudice to most of us. We have a similar disinclination to eat raw meat. Peptone from beef is, however, an article used for the dietary of invalids, and its ready adoption may very likely have been because of the change in color brought about in the digestion of meat in producing peptone. It would seem, therefore, that if the nutritive constituents of blood could be freed from the red color and offered in an attractive form for food use that such a product should be useful.

Previous to the invention of W. B. Wescott as disclosed in patent application in December, 1922, no commercially attractive process, in so far as is known, had been offered for the approximately quantitative recovery of these valuable blood proteins in such form that they might be used for edible purposes. The Wescott invention involves the use of a specially designed centrifuge which separates the prepared blood into its plasma and its hemoglobin without the rupture of the red corpuscles. This process is part of the procedure of the American Protein Corporation in its present production of these separated blood proteins. In its plant in one of the packing houses where sufficient volume of blood from animals slaughtered under Government inspection for food purposes is obtainable, blood proteins have been manufactured over a sufficiently long interval of time to demonstrate the practicability of the process and the utility of the product.

After the animal has been "knocked" and has been moved to slaughtering position an incision is made in the usual manner for bleeding the animal. A special knife with tubular handle is used so that the blood runs out into the container without contact with the hide of the animal. Each blood container has previously received a quantity of anti-coagulant to prevent the clotting of the blood. The blood from the approved animals is then passed through the special centrifuge from which comes forth one stream of straw-colored plasma and one stream of heavy liquor containing all the red corpuscles.

The red liquor is sent to a special spray drier and there reduced to powder, while the plasma goes on through the process of removing fibrin and certain lipin-like bodies, which, if retained, would render the final product subject to development of rancidity, and after concentration under vacuum is dried to a powder in another spray drier.

Prepared from blood of inspected animals, processed without handling, and under sanitary conditions, the final dry serum albumin is a yellowish powder without objectionable odor or taste and entirely suitable for food purposes.

This powder is soluble in water and a suitable solution can be whipped with an egg beater and takes the characteristics of beaten white of egg. Where egg whites are used in baking, this product has been used with eminent satisfaction, and the resulting bakery products are without taste or odor differing from similar products made from eggs. The powder can be mixed with dried egg yolks and then used in the same manner as dried whole eggs for cakes, cookies, omelets, etc.

The volume for such food uses is very great. Each year there are imported from China dried egg whites in thousands of tons. It is confidently expected that the dried serum protein, processed under clean conditions, will be a welcome substitute for the imported article. Time alone will tell to how many other uses this product will be applied.

The hemoglobin, made also in a clean manner, is used now for medical and technical purposes. Fibrin, as a by-product, can be rendered into peptone or other useful protein derivatives. All of these protein products have potential food value, and the applications to the future conservation of food material can only be surmised.

ELECTROLYTIC WHITE LEAD, ZINC RECOVERY

ANACONDA COPPER MINING CO., PERTH AMBOY, N. J.

White lead, the most important of all pigments, was the first protective pigment used by man. The Romans used a native lead carbonate, Cerrusite, but this mineral is restricted in its distribution and the artificial product was in time brought into use. The so-called "Dutch Process" for the manufacture of white lead is one of the oldest chemical processes

on record, reference being made to it as far back as 1622. With practically no changes, this process has been handed from generation to generation until even today the bulk of white lead produced is made by the "Dutch Process" following the same procedure as in 1622.

A radical departure in the manufacture of white lead was the introduction by the Anaconda Lead Products Company of an electrolytic method for the production of white lead. Following the usual electrolytic procedure lead is dissolved from a lead anode and white lead of a true basic carbonate composition ($Pb(OH)_2.2PbCO_3$) is precipitated in the cathode compartment of the electrolytic cell. The electrolytic process differs from all other methods of producing white lead in that the process is carried on without the use of acetic acid or acetates, thus all defects resulting from the presence of acids in the final product are eliminated.

The particles of Anaconda Electrolytic White Lead, due to its methods of manufacture, are molecular in fineness, which has the advantage of increasing the hiding power by 10 to 15 per cent over ordinary white lead, and of increasing the oil adsorption. As a result electrolytic white lead paint film contains enough oil to give it the hardness and gloss necessary for long service, and pigments made from this white lead remain in suspension without differential settling of the pigment to the bottom of the containers. In addition, the electrolytic process of manufacture, because of its method of control, produces a product of brilliant whiteness and superior opacity as compared with white lead manufactured by other processes.

* * * * *

There is a vast quantity of ores in this country containing zinc, lead and silver, which are not suitable for the ordinary blast furnace treatment without losing one or more of the valuable constituents of the ore. This has been known as the "Complex Ore" problem, and has concerned metallurgists for many years. The process devised by Anaconda Engineers under the direction of Mr. Frederick Laist has effectively solved this problem particularly for Montana Ores, and has made possible the recovery of large amounts of lead, zinc, and silver from ores which could not otherwise have been commercially treated.

Ore is roasted to convert zinc sulfide to zinc oxide and leached with sulfuric acid. The residue containing the lead and silver is smelted for the recovery of lead and silver. The zinc sulfate solution is purified from all impurities, and the zinc finally deposited by electrolysis as exceedingly pure zinc.

The Anaconda zinc process has therefore contributed to our modern chemistry and metallurgy two important economic factors:

(1) It has made possible the recovery of large amounts of lead, zinc, and silver which otherwise could not have been commercially produced.

(2) It has made possible the production of a pure, high-grade zinc from any source of ore whatever.

BAKELITE

BAKELITE CORPORATION, NEW YORK, N. Y.

The production and industrial development of phenol-formaldehyde resins, of which Bakelite resin is the foremost representative, is one of the most interesting and important achievements in organic synthesis. The formation of resinous bodies by the condensation and interaction of phenolic bodies with aldehydes is characteristic, but the material of the greatest industrial importance is that formed by heating together pure phenol and formaldehyde.

In the process of manufacturing Bakelite resin, weighed quantities of phenol and formaldehyde solutions are put in a closed, jacketed kettle and steam is turned into the jacket until the reaction proceeds actively. When the reaction is complete, which is a matter of a few hours, it will be found that the contents of the kettle have separated into two layers, an aqueous layer above and a layer of molten resin below. The resin, freed from water, is the basis of the various forms of phenol resin products found on the market today, and sold under the name "Bakelite."

These forms are of four general kinds:

1. Transparent Resin.
2. Molding Materials.
3. Liquid Products—Varnish, Cement, Lacquer, Enamel.
4. Laminated Sheets, Tubes, and Rods.

The Transparent Resin

Bakelite Transparent Resin is produced directly from the initial form by heat and pressure in a special type of autoclave. In this piece of apparatus, which is called a Bakelizer, the initial uncured resin is heated for a few hours at a temperature around 150°C., and under a pressure of 50 lbs. to 100 lbs. to the square inch. The heat causes the transformation to the hard, strong, infusible, insoluble resin, while the pressure prevents distortion or cracking which otherwise might result from the rapid condensation.

The resin product obtained is odorless and tasteless. It is dense and strong, but light in weight, having a tensile strength of about 7000 pounds per square inch cross section, and a specific gravity of 1.27. It will not

melt at any temperature, but begins to char at about 300°C. It is not readily burned and is chemically inert. It shows little or no deterioration with age under the influence of the elements, and is unaffected by water and all ordinary solvents, oils, dilute mineral acids (including hydrofluoric), organic acids, chlorine, and most other reagents.

Molding Material

Molding material is prepared ordinarily by the impregnation of cellulose substances with the initial "uncured" resin. Molded products are formed from the material by an application of heat and high pressure in hydraulic presses with hardened steel molds. In the production of suitable molding material, certain fibrous substances, notably wood flour, are intimately incorporated with the uncured resin. These, when properly employed, give a product having suitable flow in the mold when subjected to heat and pressure, with less shrinkage and greater toughness than is possessed by the pure resin.

Metal parts may be imbedded in the molded piece at the time of molding, thus saving much labor and expense over the method of assembling this work by hand, as was necessary before the advent of Bakelite molding materials. Electrical instrument makers are especially benefited in this regard. Added to the economy of assembly is the saving of labor in finishing the molded product. A mold having a highly polished inner surface yields a molded object of highly lustrous finish as well as copying faithfully every minute detail of the mold.

Liquid Products

Bakelite Varnish is of rare value in coating or impregnating materials to fortify their durability, and for the insulating of electric coils, windings, etc.

Bakelite Lacquer produces a hard, transparent, and resistive coating for highly finished metal. Its widespread use for protecting vanity cases and many forms of hardware is a natural consequence.

Bakelite Enamel for protecting metal from corrosion and the destructive action of chemicals is making industrial equipment function longer and better under adverse conditions which previously had made frequent replacement imperative.

As a cement for bonding metal, porcelain, wood, rubber, fiber, and glass, and where tenacious heat-resisting material is required, Bakelite is doing its part with credit. Its effective use in sealing glass bulbs in metal sockets will suggest to the reader many related applications.

The Laminated Product

In the manufacture of Bakelite Laminated the same uncured resin is employed, dissolved in alcohol, for the impregnation of sheets of paper or

of cloth. These sheets after being freed from alcohol are piled upon one another to the desired thickness and subjected to strong pressure between the heated platens of a hydraulic press.

The heat and pressure are roughly like those employed in the molding operation. The resin first fuses, binding the sheets together, and then sets, incorporating them into compact, dense, tough, homogeneous plates, or sheets, of uniform character. They in no way resemble the layers of paper or cloth from which in part they are made. The mass of Bakelite-laden layers is completely transformed by the heat and pressure into a tough plate which cannot be re-softened by heat, is non-hygroscopic, and is possessed of unusual mechanical and dielectric strength.

With the aid of steel mandrels laminated tubes are formed of any desired diameter and thickness. Rods of the same material are also produced. The paper-laminated stock finds much use in electrical industries, and in sheet form is best known in radio panels. Cloth-laminated Bakelite finds its principal service as the material for silent gears. It is stronger than cast iron and possesses certain advantages over raw-hide, particularly where exposed to dampness, oil, or the attack of vermin.

OPTICAL GLASS

BAUSCH & LOMB OPTICAL CO., ROCHESTER, N. Y.

Optical glass differs radically from other varieties, both in its properties and in its method of production, due largely to the fact that glass for optical purposes is required in comparatively large, thick pieces, while ordinary glass is commonly used in thin sheets.

Optical glass first appeared on a commercial basis as the result of Dolland's invention of the achromatic telescope objective in 1757, ordinary glass having been found so lacking in homogeneity as to be quite useless for lens work. From this point the manufacture of optical glass went through various stages of development by such men as Guinand, Utschneider, and Fraunhofer.

The most distinctive advance in optical glass manufacture was instigated by Professor Abbe of Jena, Germany. He obtained the collaboration of Dr. Schott, and together they founded the institution of Schott & Genossen at Jena, which resulted in a few years in the production of a whole series of new glasses which were novel in composition and optical properties.

In recent years, experiments were conducted in the manufacture of optical glass in America. In 1903 the Bausch & Lomb Optical Co., of Rochester, began experiments, but it was not until 1912 that the enterprise was gone into on a serious basis. The early efforts at this plant

were not at all auspicious, and most of the year 1913 was devoted to the study of all available information regarding the making of glass, and conducting practical experiments with various kinds of fuel.

The war in Europe had the effect of stimulating these experiments, and in the winter of 1914 a special building was erected with two gas firing furnaces and one pot arch or smaller furnace, which is used for the preliminary heating of the pots.

The first melt of barium crown glass in May, 1915, was purple in color and not usable. In the third week of the same month, however, some light crown and dense flint glass was produced which could be used. During the following month light flint glass was also successfully produced, and experiments were begun on most of the other types in more common use.

It must be said here, in all justice to those concerned and to the Government's agencies, that when America entered the war in April, 1917, one of the first objects of the Government's concern was a supply of optical glass. The Government authorities accordingly made a survey of the situation and found that of the several establishments at that time contending with the problem, the Bausch & Lomb Optical Company was the only one actually producing satisfactory glass. As a result, the Council of National Defense suggested that the Geophysical Laboratory of the Carnegie Institution in Washington, D. C., which had been turned over to the government at the outbreak of the war, establish a research laboratory at our plant.

The chief difficulty up to that time had lain in the high absorption of light in the glass produced. The government workers were instrumental in obtaining purer raw materials, with which this difficulty was overcome, and it then became a case of trying out different methods of stirring and temperature control in order to produce glass of the highest quality.

The problem of pots, or crucibles, was a very difficult one that had to be solved along with the solution of the manufacturing problems of optical glass. For this reason it became necessary for the Bausch & Lomb Optical Company to build a separate building in which the manufacture of special crucibles was successfully undertaken. In this connection Dr. Bleininger, formerly of the Bureau of Standards, was an important factor, and it was largely through his efforts that Bausch & Lomb developed suitable pots in which optical glass could be made. At the present time the Glass Plant of the Bausch & Lomb Optical Company is of such a size and capacity as to produce all of the optical and ophthalmic glass used in the manufacturing activities of that concern.

The exhibit was composed of an optical glass display, showing chiefly three methods of producing lenses. The first method is the method which was used at the beginning of the glass-manufacturing activities of the

Bausch & Lomb Optical Company. In this method the glass, from the rough chunk which is broken out of a pot of glass after having cooled, is reduced to the approximate form, shape, and size of a lens by a sawing and milling process.

The second method, which was established or developed during the war, was by procuring the shape, form, and size of the lens by means of various pressings of the glass, heated to a plastic state.

The third method exhibited showed the steps taken in the ophthalmic or spectacle lens glass manufacturing. This differs from the optical glass manufacturing in that the glass made in the same type of a crucible is poured in its liquid state onto a large steel table top and rolled into a huge sheet. This sheet is then cut up into smaller pieces to the weight of the lens to be made. These small squares are then heated to a plastic state and pressed into the approximate form and size of the lens desired.

The exhibit also showed the various ingredients used in the manufacture of glass, including sand and salts.

PERMALLOY

BELL TELEPHONE LABORATORIES, NEW YORK, N. Y.

The name "permalloy" is applied to certain nickel-iron alloys which, when properly heat-treated, possess remarkable magnetic properties. These properties are developed in alloys which contain more than 30 per cent of nickel and the atoms of which have the face-centered cubic arrangement characteristic of nickel rather than the body-centered crystal structure characteristic of iron. While alloys throughout the entire range above 30 per cent nickel exhibit these properties to some degree, the most remarkable magnetic effects are obtained with alloys containing nickel and iron in the ratio of about 80 per cent nickel to 20 per cent iron. In the manufacture of permalloy it is desirable to use the purest commercial nickel and iron. The analysis of one typical sample in per cent was as follows: Ni 78.23; Fe 21.35; C 0.04; Si 0.03; P trace; S 0.035; Mn 0.22; Co 0.37 and Cu 0.10.

The heat treatment of permalloy is of the utmost importance. To develop its highest permeability it must be cooled not only through the proper temperature ranges but also at the proper rates. Each size and shape of finished product has its own best heat treatment.

A magnetizable material placed in a magnetic field has established in it a magnetic induction, the amount of which depends upon the intensity of the field to which it is exposed and upon a characteristic of the substance known as its permeability. This permeability is the factor by which the magnitude of the cause, namely the field, must be multiplied in order

to obtain the effect, namely the induction. Permeability, however, is not a constant factor independent of the magnetic condition of a ferromagnetic substance. For example, doubling the magnetic field does not necessarily double the magnetic induction since the ease of magnetization, that is the permeability, may be markedly greater or less under this new condition. It is in its initial permeability and its ease of magnetization under very feeble magnetic fields that permalloy is most remarkable. So sensitive may it be made that it will be saturated magnetically in the earth's magnetic field.

The magnetic properties of permalloy are affected by strain; for example, in a particular case the maximum permeability may be reduced from its value in the unstrained condition to about one-tenth that value merely by variations in tension within the elastic limit. The electrical conductivity of the material is similarly sensitive to strain through a much smaller range of only a few per cent, but at a rate which is large as compared with that of other metals.

In electrical communication relatively intense magnetic effects are frequently desired to be produced by the very feeble currents used for signalling or for the transmission of speech. The discovery and development of permalloy, therefore, promises enormous assistance to the communication art because of its ease of magnetization by the magnetic fields produced by feeble currents.

In submarine cables of practical dimensions greater speed of signalling can be obtained if the signalling currents can be caused to produce in the surrounding space a suitably greater magnetic flux, that is, if the distributed inductance of the cable can be suitably raised. An increase in speed of signalling from the ordinary limit of about 250 to over 1900 letters per minute was attained in the case of the New York-Azores cable by designing both the cable and its terminal apparatus to take advantage of increased inductance of the former obtained by magnetically loading it with permalloy. The central conductor of the cable was wrapped with a thin tape of permalloy and thus surrounded by a medium in which the feeble signalling currents produce relatively enormous changes in magnetic induction.

PYREX

CORNING GLASS WORKS, CORNING, N. Y.

The first deliberate study and efforts by a manufacturer of glass in the United States to produce a glass of superior mechanical strength and with real qualities of heat and chemical resistance were made by Corning Glass Works of Corning, New York. The Corning Glass Works had the specific problem to solve of devising a glass for the inner globe of street arc lamps

that would resist the intense heat generated by the arc and the extreme temperature variations incident to outdoor use, and its efforts were at first instigated by this problem. There was little to guide them in their study. The pioneer work of Otto Schott of Jena had shown that of the six factors or properties determining the ability of glass to withstand sudden changes in temperature the linear expansion coefficient could be most easily and widely varied. Disregarding quartz glass and speaking only of glasses that can be melted and worked by usual methods, the expansion of glass can be varied in the ratio of six or more to one. The other properties influencing heat resistance cannot be varied over any such range. Corning's line of research, therefore, was toward a glass of low linear expansion; but in securing that property the composition could not be varied in directions that would adversely affect the melting and working qualities of the glass.

The steady progress made by Corning Glass Works' laboratory toward the definite goal that has been set from the beginning of their research, and the great commercial success attained with the heat-resisting glass products that had been marketed, paved the way for what was perhaps the most daring and most distinctly novel idea for an application of heat-resistant glass that had yet been made—the use of it as a material for oven cooking utensils. To attain any measure of success in this field it was necessary to intensify and increase all of the effects already secured in the new glass. The first large shipment of baking ware now known throughout the world as Pyrex, was made by Corning Glass Works in May, 1915, after several years of intensive study and experiment and after wide distribution of such ware made for test purposes.

During the year 1914, a new commercial application for this versatile glass, of vital significance to the chemical industry, was undertaken in a small way. In that year flasks, beakers, and laboratory apparatus were first made. As has been pointed out, development of a successful oven cooking glass has necessitated great improvement in the heat resistance and non-solubility. These very qualities gave, ready to hand, a laboratory glass superior to any known glass, foreign or domestic. American laboratories, both industrial and educational, had long depended for their glass apparatus on the foreign makers. Jena glasses had been regarded as the standard of the world in this field; but when the war caused the gradual drying up of imports from Germany, Corning was fully prepared to help the American chemist in his difficulty. Chemists throughout the country, knowing of the remarkable properties of Pyrex from its other demonstrated uses, virtually demanded it for their laboratories; and the Government itself seconded this demand when war industry and research enormously increased the use by the Government of chemical glassware. It was in the spring of 1915 that Corning placed on the market a complete line of

flasks, beakers, test tubes, and fabricated apparatus in Pyrex—a line that has grown steadily in popularity till now scarcely a laboratory in the country is without its quota of Pyrex chemical ware. Foreign chemists, too, have recognized the value of Pyrex, which is now invading the home markets of the best foreign glass in steadily increasing quantities.

It should be borne in mind that research work for improving Pyrex and for widening its commercial uses is by no means finished; in fact, the present applications of Pyrex, diverse as the appended list shows them to be, are believed to represent only a beginning of the possibilities in this remarkable glass; and Corning's laboratory organization is making constant progress in perfecting new uses for it. Of particular interest to the chemical industry has been the logical step from the laboratory use of Pyrex to actual production uses in chemical-manufacturing plants. Pyrex pipe and fittings from one to six inches in diameter are now widely employed for conveying hot liquids and acids. Evaporating dishes, cascade dishes, and other forms of Pyrex utensils and apparatus find a ready market as replacement of more expensive and less reliable materials.

PRESENT PYREX PRODUCTS

Laboratory and Scientific Ware:

Flasks, beakers, test tubes
Fabricated apparatus
Tubing and cane glass
Observatory lenses
Condenser lenses
X-Ray shields.

Household Ware:

Oven cooking utensils
Tea pots
Percolator tops
Nursing bottles
Refrigerator dishes
Measuring cups.

Railroad Ware:

Lantern globes
Chimneys
Battery jars
Headlight glasses
Gage glasses.

Industrial and Equipment Ware:

Pipe, elbows, tees, etc.
Cascade dishes
Evaporating dishes
Oven door panels
Cylinders for gasoline pumps
Cylinders (various)
Coffee-urn liners
Steam-table liners
Sight glasses
Carboys.

Insulators and Radio Parts:

High tension insulators
Broadcasting, reception, and other special radio insulators
Radio tube sockets, condenser parts, and other specialties.

CRODON: THE NEW CHROME ALLOY PLATE

CHEMICAL TREATMENT CO., INC., NEW YORK, N. Y.

Commencing with the later years of the 19th century and extending up to the present, there has been a constantly growing appreciation on the

part of chemists and metallurgists of the distinct and valuable properties of chromium and its alloys. More particularly, the properties of hardness and rust-resistance have led to the development and perfection of a number of alloys which have found wide application in industry and the arts.

It has long been apparent that there would be a large field and hundreds of uses for a thin plate or sheathing of chromium over other metals, particularly in the case of products where the hardness of such a plate would make it possible to use a base metal more easily machined than the hard chrome alloys, and also where rust resistance is a factor of importance.

Among the first to apply themselves to the solution of this problem was Dr. Colin G. Fink, head of the electro-chemical department of Columbia University, who is internationally known as the discoverer of the electro-chemical process by which ancient corroded metals are restored to their original form by a reversal of the process of corrosion.

The result, after years of experimentation and research, was the perfection of Crodon.

Crodon is an alloy composed almost entirely of metallic chromium. Applied by the new Fink process as a plate over other metals, it has the following properties:

1. *Hardness:* In the harder grades, harder than the hardest steel.
2. *Rust-proof:* Resists rust, tarnish, and corrosion indefinitely. No polishing required on Crodon-plated articles.
3. *Acid-proof:* Immune to the attack of practically every acid.
4. *Heat Resistance:* Crodon plate will withstand temperatures up to 2500°F.
5. *Tightness:* A Crodon plate will not chip, crack, or peel.
6. *Surface Wear:* So resistant to surface wear that the usual buffing compounds will not strip a Crodon plate.
7. *Finish:* For different uses Crodon can be applied in a variety of finishes ranging from a dull satin to a bright high-luster polish.
8. *Color:* Where appearance is a factor, Crodon possesses a basis of individuality in its soft blue sheen akin to that of platinum, which permits of no confusion with nickel plate.

DUCO, OVAL SHOTGUN POWDER, LOW-FREEZING DYNAMITE, RUBBER ACCELERATORS, DYES

E. I. DU PONT DE NEMOURS & COMPANY, INC., WILMINGTON, DELAWARE

Five outstanding du Pont products, representing great steps forward in American business, were chosen to be represented in the Court of Chemical Achievement.

Duco was one of the outstanding products selected to be honored by a place in the Court. The development of Duco marks the opening of a new era in finishes widely adapted to the requirements of the automobile and furniture industries, and at this time already adopted by them. The development of this new finish with its unusual properties of hardness, toughness, durability, and methods of application has resulted, too, in rapid expansion of its use in other fields.

Du Pont Oval Shotgun Powder was another outstanding product selected for a place in the Court of Chemical Achievement. This powder owes its superior properties to certain modifications in its fabrication, as well as the use of some new ingredients. It is the result of the experience which the du Pont Company has accumulated through more than a hundred years of research and manufacture of all varieties of military and sporting powders. Du Pont Oval Shotgun Powder is a progressive burning powder which enables the sportsman, with existing guns, to obtain results hitherto unobtainable in sporting guns at any price or of any degree of fineness of manufacture.

Low-freezing straight dynamites manufactured by the du Pont Company were also honored by a place in the Court. The manufacture of these dynamites was regarded as one of the most important steps forward in this explosive since its invention. The perfection of the formulae was the result of years of experimentation in the laboratory and in the field, and made it possible to use straight dynamites the year round in industrial operations. The explosives are proof against freezing, even in zero weather. In fact, tests have shown them immune to freezing even at thirty-five degrees below zero.

Du Pont Company rubber vulcanization accelerators comprised another achievement honored by exhibit in the Court. The development of a considerable variety of rubber vulcanization accelerators by the du Pont Company was a logical outcome of the establishment of the dyestuffs industry in this country and the prominent place which the du Pont Company has assumed in connection with this development. These accelerators are the result of three years' research work and enable the manufacturer of rubber goods to turn out his products with a wide variety of physical and chemical properties. In fact, the analogy between the control of the tempering or vulcanization of rubber and the control of the properties of the ferro alloys such as steel is rather striking in that not only the constituents of the finished product are varied with a view to meeting specifications as to hardness, toughness, flexibility, heat resistance, ductility, and the like, but the method of tempering the finished product by the amount and degree of heat treatment is, in the case of rubber products, brought under complete control by the selection of some one of these new rubber accelerators and proper adaptation of conditions to the desired

ends. One of the principal accomplishments of the rubber industry, the manufacture of high-grade automobile tires with wonderful wearing qualities, has been brought about largely through the development of rubber vulcanization accelerators which have enabled the tire manufacturer to modify his methods of curing, that is, vulcanizing the rubber contained in his products. There is, perhaps, nothing that has contributed more greatly to the economy and pleasure of modern motoring than the practically complete freedom from tire worries.

A number of du Pont dyes also had a place in the Court. Some of these dyes are produced by exceedingly complex processes in that a large number of separate steps are required to produce the finished product. Painstaking chemical development is responsible, quite obviously, for the evolution of a chemical process, every step of which must be correct, both as to the quality of the product and the yield, to enable the end product, that is, the finished dye, to be placed in the hands of the user at suitable prices. Uniformity is one of the indispensable characteristics of any dye since successive batches of fabric must exactly match in shade. No instrument has ever been constructed so delicate as the human eye in the detection of minute differences in shade. It follows, therefore, that the quality of the product must be beyond question before a conscientious manufacturer can place it in the hands of the consumer.

The dyes represented in the Court of Chemical Achievement are Ponsol Golden Orange G, Ponsol Golden Orange 2RT, Sulfanthrene Pink FF, the Gallopont Colors and the Luxol Colors. The first three are vat dyes. The Gallopont Colors are used in calico printing particularly, and the Luxol Colors are used in making wood stains which are fast to light, as dyes for pyroxylin material and in transparent lacquers such as Duco.

SOME RECENT ACCOMPLISHMENTS OF THE CHEMICAL WARFARE SERVICE

The Production of Smoke for Screening Military Operations

The Chemical Warfare Service is probably the only scientific organization in this country studying the controlled production of smoke with special reference to possible smoke materials, methods of production, travel and dilution of the smoke in the field, and the obscuring power under field conditions. This is an entirely new field of investigation and the fundamental knowledge acquired may later be applicable to strictly industrial purposes.

The most spectacular development in this field since the war is the falling smoke curtains dropped from an aeroplane. Picture No. 1 shows a smoke curtain. By releasing the smoke-producing liquid from the plane at the

same velocity as the plane, and in the opposite direction, the liquid falls in stable drops like rain. By the selection of a liquid which reacts with the moisture of the air to produce smoke, a curtain is formed as the drops fall to the ground. This curtain, when dropped from a Martin Bomber spreads over one and one-third miles with the use of eight hundred pounds of liquid. The curtain is laid in less than a minute and gives effective screening against land observation for about fifteen minutes, depending

Picture No. 1.

largely on meteorological conditions. Patents covering these developments are now pending.

Picture No. 2 shows a smoke screen produced by releasing the smoke-producing material through the exhaust of an aeroplane. The material is carried out by the exhaust gases and produces a smoke in the air. This equipment is used for screening land or naval movements.

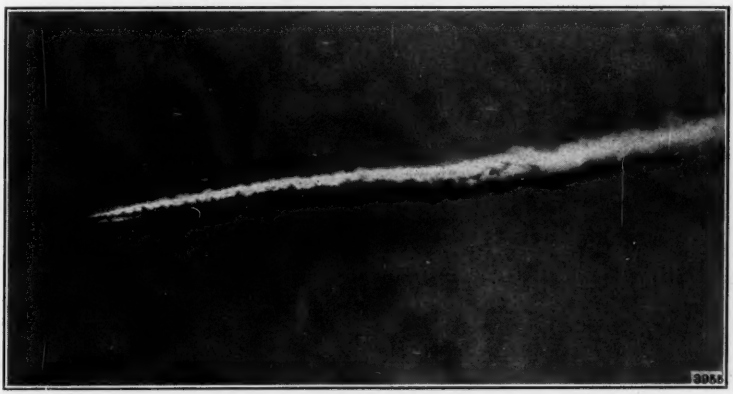
Stokes Mortar Smoke Shell (H. C.)

This shell was designed to produce large smoke clouds for land screening. The shell is filled with a mixture of hexachloroethane, zinc oxide, and powdered zinc. The fuse functions upon impact and ignites a suitable starting mixture which in turn sets off the shell filling. The pressure, generated by the gases in the shell, blows off the covering from the vent holes and allows the smoke to escape in the air. A dense white smoke is

produced from each shell for a period of from seven to ten minutes. The smoke produced is essentially zinc chloride saturated with moisture.

H. C. Smoke Candle

The H. C. Smoke Candle has been developed to provide the Infantry with a safe and convenient source of smoke for relatively small screens. The candle contains a mixture which includes zinc and hexachloroethane, and produces a zinc chloride smoke. The candle, being flat shaped, can easily be carried in the pocket, is safe and will burn on ignition for about three minutes, giving off a dense white smoke. The candle is fired by drawing the scratcher block across the match head mixture which fires a starter;



Picture No. 2.

this in turn ignites the mixture. The smoke escapes from the container through the zinc starter cup which is melted by the burning starter.

White Phosphorus Hand Grenade

This grenade consists of a metal body loaded with ordinary white phosphorus. Through the center extends a burster filled with a suitable explosive. Five seconds after the grenade leaves the hand, the firing mechanism functions and the explosive fragments the grenade body. The white phosphorus is thrown into the air and ignites spontaneously, giving a dense white smoke. The W. P. Grenade is used for close contact work, covering a circular area of about fifteen yards diameter.

Public Health Service Canister

The Chemical Warfare Service developed a special canister for protection against hydrocyanic acid and cyanogen chloride, due to the increasing number of fatalities in fumigation work with hydrocyanic acid alone.

A fumigating mixture, consis ng of cyanogen chloride and hydrocyanic acid, was also developed. The canister is loaded with two adsorbents; an impregnated charcoal and an alkaline granule. The United States Public Health Service coöperated in the development of this canister and fumigant. The canister will afford complete protection against hydrocyanic acid and cyanogen chloride for many hours at the concentration used in fumigating a ship. This canister is protected by patents.

Ammonia Canister

This is a special canister developed to provide protection against ammonia leaks occurring in refrigerating plants and other industrial plants. The canister is filled with a special impregnated charcoal.

Lachrymatory Munitions

The training of troops in Chemical Warfare is dependent on the use of materials which are not toxic or dangerous but which produce momentary effects. Since the war several training munitions have been developed. Most of these use an intimate mixture of chloroacetophenone (C. N.) and smokeless powder; the heat of the burning powder volatilizing the chloroacetophenone. There is no fragmentation of the container in these munitions and no toxic effect or permanent irritant action. The C. N. produces a temporary irritation of the eyes.

C. N. Hand Grenade

The C. N. Hand Grenade functions five seconds after the grenade leaves the hand. The grenade develops a lachrymatory cloud which drifts downwind. The device burns for one minute and produces an effective concentration of chloroacetophenone in the air. This munition is covered by patents now pending.

C. N. Cartridges

Cartridges have been developed for the use of police and other representatives of the law which may be used in standard firearms and which on firing develop a sufficient concentration of tear gas to force the evacuation of a room or other enclosure. Three of these cartridges were shown at the exhibit. One is adapted to the regulation rifle, one to the .45 automatic pistol and one to a shot gun. The cartridges are loaded with a mixture of C. N. and smokeless powder. These devices are covered by patents now pending.

C. N. Candle

The candle is loaded with a mixture of C. N. and smokeless powder. The device is ignited by drawing the scratcher block across the match head which fires the starter. This in turn ignites the main mixture. The tear gas vapors leave the candle through the hole in the center of the top.

The candle produces an effective concentration of tear gases for approximately six minutes. This device and mixture are covered by patents now pending.

McBride Gas Gun

This is a small and easily portable unit similar to the mobile gas cylinders used in the late war. The device consists of two parts, a chamber loaded with a liquid lachrymator or a solution of a solid one; and a compartment filled with gas under pressure. By operating the valve on the pressure cylinder, the lachrymatory solution is atomized with the gas. The device is intended for use in training troops and in extraordinary police work. This device is covered by a patent applied for.

Marine Piling Specimens

The havoc wrought by teredo borers to wooden docks and piling prompted an investigation leading to the protection of marine structures. The exhibit showed unimpregnated blocks before and after exposure in the harbor at Beaufort, N. C.; and an impregnated block exposed at the same time.

"Medical Aspects of Chemical Warfare"

BY LT. COL. EDWARD C. VEDDER

For three years before the publication of this book Colonel Vedder was Chief of the Medical Research Division of Edgewood Arsenal. Colonel Vedder has assembled most of the available data on the medical aspects of Chemical Warfare and placed it in such form that the layman can read the matter intelligently.

Photograph Album

Illustrations of some other activities of the Chemical Warfare Service were shown in a photograph album.

SYNTHETIC ORGANIC CHEMICALS

EASTMAN KODAK CO., ROCHESTER, N. Y.

The exhibit of the more than two hundred Eastman synthetic organic chemicals represented large laboratory scale production of a wide variety of chemicals of high purity. There were too many of them to detail the possible applications for each but some may be mentioned.

There is 4-aminodiphenylamine which develops a dark color when applied to animal fibers, and thus finds application in hair dyes. 2,5-Diaminotoluene is of especial value for the same purpose since it does not cause the dermatitis ascribed to the use of *p*-phenylenediamine. Alloxan

is a colorless substance which develops a light pink color when applied in the form of a dilute solution to the skin; this finds application in the preparation of cosmetics.

Ethyl anthranilate is employed for the preparation of perfumes and artificial flavors, while ethyl pelargonate is a liquid of pleasant fruity odor also employed in the preparation of artificial flavoring materials.

Of interest to chemists generally is magnesium perchlorate trihydrate, a new and efficient desiccating agent. 2-Hydroxy-1,3-dimethyl-benzene is a rare xylenol employed in the preparation of new sulfonphthalein indicators. Nitrosomethylurethane on treatment with alkali is converted into diazomethane, which finds application as a methylating agent for certain sensitive phenolic compounds. Ethyl orthoformate is employed for the synthesis of aldehydes by the Grignard reaction. *o*-Phenylenediamine is employed in syntheses and for the detection of ortho-quinones.

Among the analytical reagents we encounter aluminum ethoxide which has been employed for the detection and estimation of traces of moisture. *a*-Benzoinoxime is a new reagent for the detection of copper and certain other heavy metals. Dinitrosoresorcinol is useful for the detection of minute quantities of iron. Aurin-tricarboxylic acid is a new reagent for the detection of aluminum. *p*-Bromobenzenesulfochloride has recently been recommended for the identification of amines. *a*-Naphthylisocyanate is of value for the identification of amino acids and other amino and hydroxy compounds. *m*-Nitrobenzhydrazide is occasionally employed for the characterization of aldehydes and ketones. Benzylphenylhydrazine hydrochloride is of use for the identification of sugars, particularly pentoses, which fail to give satisfactory derivatives with other reagents. 2,4-Dinitrophenylhydrazine is a new reagent for detecting and estimating small quantities of acetone. Phenolphthalein has been found by government chemists to form a delicate test for the detection of blood stains. 3,5-Dinitrosalicylic acid is employed in a new method for determining glucose in urine.

Xanthine is a purine of interest to biochemists, as is also adenine sulfate.

Tetraiodophenolphthalein has awakened considerable interest lately as a drug for causing the gall bladder to cast a shadow under X-ray radiation. This has rendered diagnosis of gall bladder trouble much more certain than heretofore.

METALLIC TANTALUM

FANSTEEL PRODUCTS CO., INC., CHICAGO, ILL.

Tantalum is a relatively rare metal which has only recently been utilized to any considerable extent or manufactured in commercial quantities. The oxide of this metal is found in combination with the oxide of iron in the mineral known as "Tantalite."

Metallic tantalum was first produced in a pure state in the year 1903 in the plant of the Siemens & Halske Co. in Germany, and for a number of years drawn tantalum filament wire was produced and used in the manufacture of incandescent lamps. The metal is also used to a limited extent in the manufacture of certain dental and surgical instruments.

In 1911 the tungsten filament lamp entirely replaced the tantalum lamp and until quite recently there appeared to be no material demand for this metal and very little was produced.

When properly prepared, metallic tantalum is one of the most ductile metals known. It resembles platinum very much in color and appearance. Its melting point is exceedingly high, being in the neighborhood of 2850° C. It is a heavy metal, having a specific gravity of 16.6. It is tough, malleable and possesses ductility to so great a degree that it may be subjected to a very large amount of mechanical working without excessive strain hardening. It can be rolled into sheet, hammered or drawn into wire. The tensile strength of drawn wire may reach 130,000 pounds per square inch. The linear coefficient of expansion is considerably more than that of molybdenum or tungsten and only slightly less than that of platinum. It has been found possible to make glass seals with tantalum wire. Its electrical resistance is quite high, being about eight times that of copper or about three times that of tungsten.

In considering the possible uses for this metal we may take into account its high melting point, its resistance to chemical corrosion and its tendency to absorb the common gases—and also its relatively low temperature of oxidation. It must also be taken into account that tantalum is a relatively expensive metal and probably never can be made to sell at a very low price. However, within certain limitations this metal should find quite a number of commercial applications. Wherever small quantities of a metal highly resistent to chemical corrosion are required, it should be considered.

As already mentioned, its high melting point resulted in its use as a filament in incandescent lamps. It may still have value in this connection and in fact tantalum filament lamps are now being produced in a small way.

It undoubtedly will find application for the manufacture of apparatus for use in chemical laboratories, such, for instance, as a cathode on which to deposit metals in electro-chemical analysis. The most recent application of tantalum and one which has involved the use of considerable quantities of the metal depends upon its property of acting as an electrolytic valve. The tantalum electrolytic rectifier has been found a very suitable device for maintaining the charge in the batteries used in operating railway signals. The use of metallic tantalum in other connections is still a matter of experiment and development and unquestionably many of its possibilities are as yet undiscovered.

HEAT-ENDURING ALLOY RESISTING THE ACTION OF ALKALI COMPOUNDS UNDER OXIDIZING CONDITIONS AT 2150°F.

VICTOR HYBINETTE, WILMINGTON, DELAWARE

The heat-resisting alloys which are in praetical use today are approximately of the following compositions:

A. 80% nickel, 20% chromium
B. 60–65% nickel, 12–17% chromium, 17–25% iron
C. 30–40% nickel, 15–20% chromium, 40–50% iron
D. 25–30% chromium, 70–75% iron.

These four types of alloys will all of them withstand temperatures from 1800° to 2000°F. for several thousand hours. It has been well-known that soda salts affect these alloys and in many cases shorten their life to such an extent that they lose their practical usefulness. It has been taken for granted that all alloys of chromium, nickel, and iron suffer from the same trouble. The above-named alloys are not attacked in exactly the same proportion. Alloys "A" and "D" are considerably more resistive to alkali than "B" and "C." This has been known before and it has been explained by the absence of iron in the case of alloy "A" and by the absence of nickel in the case of alloy "D."

Upon further investigation it has been found that an alloy consisting of approximately one-third each of chromium, nickel, and iron is far more immune to the action of soda than any of the above-named alloys. Incidentally this alloy is more heat-resisting in the absence of soda salts than any other combination of chromium and nickel, with or without iron, or of chromium and iron, with or without nickel. It is surprising that this fact had not been discovered before, but it is accounted for primarily by the theory propounded by Mr. A. L. Marsh when these alloys were first put to practical use, that iron was to be considered as a cheap substitute for nickel. When later the alloy of 30% chromium and 70% iron was put on the market, it was claimed that small additions of nickel did not increase the heat resistivity.

Further experiments have proved that it takes at least 20% nickel with 30% chromium to produce any marked effect and that the immunity to alkali is increased with a gradual increase of nickel up to about 35–40%. A further addition of nickel again lowers the resistivity. The same is true of the chromium content so that the limits are about 28–40%, and the best results are obtained at a chromium content of about 32%. If now an alloy is made up of 40% chromium, 40% nickel, and 20% iron, such alloy is distinctly inferior to one of 30% chromium, 35% nickel and 35% iron. This shows conclusively that the iron has a decided influence upon the characteristics of the alloy and that it cannot by any means be considered a diluting and cheapening agent.

The exhibit consisted of the following items:

Exhibit 1. Five test pieces made from the alloys A, B, C, D, and E made from the new alkali-resisting alloy. These test pieces had been submitted to heating side by side in a furnace at 2150°F. in the presence of a small amount of soda vapor. After twelve hours these test pieces were taken out and cleaned, whereupon it was found that the losses were as follows:

A—5200 mg.; B—12,900 mg; C—9700 mg.; D—9100 mg.; E—2500 mg.

Exhibit 2. A laboratory test beam $1/2'' \times 1/2'' \times 10''$, which had been subjected to heating to 2150°F. and carrying in the middle a load of 10 lbs. for twenty-four hours, without visible permanent deflection. This indicates that a fiber strain of 1000 lbs. per square inch has been endured without permanent deflection. At 1800°F. the corresponding figure is 6000 lbs. per square inch, and at 1600°F. the corresponding figure is 10,000 lbs. per square inch.

Exhibit 3. Test pieces of forged material showing structure and ductility of the metal. These test pieces have shown 135,000 lbs. tensile strength, 90,000 lbs. elastic limit, 35% elongation in two inches, and 45% reduction of area.

Exhibit 4. Fracture of castings showing the peculiar grain of the metal.

This alloy was primarily developed to meet the requirements of the California Cyanide Company, but it will undoubtedly be of greatest importance in electric heating where heretofore the heating elements have been deteriorating for some mysterious reason which is now found to be the presence of small amounts of alkali compounds in the atmosphere. It has heretofore been found impossible to heat furnaces with metallic resistors to a temperature higher than 2000°F. for any considerable length of time. It is believed now that this limit can be raised to 2150°F.

KAROLITH—THE AMERICAN CASEIN PLASTIC

KAROLITH CORPORATION, LONG ISLAND CITY, N. Y.

Karolith is the trade name for the first successfully produced all-American casein plastic material. Its development furnishes a new outlet for a practically waste product—skim milk furnishes the public with a new material in which beauty of color and finish is combined with strength, and marks a definite achievement of American science and American chemists.

Casein is the principal protein material found in milk. Whole milk contains an average of about $2^1/_2$ per cent casein: skim milk, *i. e.*, whole milk from which the fat has been removed, will average slightly higher in casein. Commercially casein is prepared by coagulation or precipitation

from skim milk by the addition of an acid, such as muriatic or sulfuric, or by the addition of an enzyme such as rennet. Acid caseins find industrial application in the manufacture of glue, paper coating, cold water paint, etc. The principal industrial outlet for rennet casein is in the manufacture of casein plastics, for which it is better suited than acid caseins. In the past, practically all the caseins manufactured in this country were acid caseins, but with the development and growth of the casein-plastics industry, it is safe to predict that a large percentage of skim milk at present wasted will be used in the manufacture of rennet casein.

One of the outstanding properties of casein which has caused its use in other industries makes its application to the manufacture of plastics possible. As casein glue causes two pieces of wood to adhere, as casein in paper-coating mixture holds powdered China clay to the paper and casein in cold-water paints holds the pigment glued to the surface painted, so casein in plastic material holds to itself, and after hardening with formaldehyde is a tough, horn-like material of high comparative tensile strength.

The development of Karolith is not, in the strict sense of the word, a discovery, since casein plastics have been made and known in Europe for a number of years. This fact does not detract, however, either from the importance of this development or from the brilliance of the achievement, as the European processes were so well protected by secrecy and a confusing mass of patent literature that it was necessary to proceed through practically the same steps of research and development as though the material were unknown.

The American casein plastic, Karolith, has been produced by the Karolith Corporation, Long Island City, New York, commercially for about a year and a half, in which time the demand for the material has doubled and doubled again.

There is no other material known at present which so ideally combines beauty with strength, durability, and workability. To this must be added the fact that Karolith is not a composition, so is uniform or homogeneous in structure, is practically non-inflammable, odorless, and tasteless. It can be made in any color or shade from a delicate coral or turquoise, to a clear amethyst or jet and the colors are not affected by exposure to the sun's actinic rays. It can also be produced in grained or mottled effects rivaling and often excelling jade, cloudy amber, horn, tortoise shell, etc., in beauty.

This material, which is chemically and practically a synthetic horn, works similarly to horn with this difference—being more uniform in structure and closer grained it produces a more lustrous and lasting polish by means of the same machinery, *viz.*—high-speed rag buff for large objects; tumbling barrels for small. It softens under influence of moderate

heat or water, so can be bent and embossed. It turns and drills readily and can be threaded and engraved. It can be dyed or stained, the dye penetrating only the surface, so it is possible to produce beautiful two-color effects by engraving designs on dyed material. These properties make it almost ideal for buttons, for which it is very extensively used.

Another field where Karolith has very successfully been applied is the fountain pen and automatic pencil industry. Previously, hard rubber or metals were used, with the result that pens or pencils which would wear well were quite expensive and were not attractive in appearance. Now it is possible to obtain beautifully colored pens and pencils which stand up well in use at quite reasonable prices, thus enabling a greater number of people to enjoy the advantages of these present-day necessities.

Karolith is also used in the manufacture of buckles, millinery ornaments, beads, toilet articles, cigar and cigarette holders, radio parts, wall electric switch plates, cutlery handles, etc.

ISOTOPES OF CHLORINE AND MERCURY AND APPARATUS FOR THEIR PRODUCTION. NEW ELEMENTS PRODUCED FROM CHLORINE AND FROM MERCURY

KENT CHEMICAL LABORATORY, UNIVERSITY OF CHICAGO, CHICAGO, ILL.

Initial Work on the Separation of Isotopes, and the Whole Number Rule for True Atomic Weights

As is usual in the development of a new process, the success of the work of separating chlorine into isotopes was due to an idea. In this case, however, the idea was not one concerning the process, but concerned rather the nature of the raw material, that is of the element, chlorine, itself. In 1915 Harkins and Wilson published for the first time the Modern Whole Number Rule in a paper in the July number of the *Journal of the American Chemical Society*. According to this rule, while the atomic weight of hydrogen is not a whole number, the atomic weights of all true elements, more exactly described as atomic species, are whole numbers within 0.1 per cent if the atomic weight of oxygen is taken as 16 or that of carbon as 12. In 1916, basing their work upon the idea from the whole number rule that chlorine was certainly a mixture, Harkins and Turner began to pass this gas through a long series of porous porcelain tubes, the stems of Scotch church-warden smoking pipes. Chlorine itself was used on account of the ease with which it could be condensed by cooling, but it was soon discarded since it was realized that if there are two isotopes of chlorine, numbered 1 and 2, there must be three isotopes of molecular chlorine as follows: 1–2, 1–1 and 2–2. If hydrogen chloride is used there can be

only one kind of chlorine in any single molecule, which increases the speed of the extremely slow separation by almost 100 per cent.

The Separation of Chlorine into Isotopes

The latest separation, made in the past two years with the assistance of Francis Jenkins, gave nearly 100 grams, with an atomic weight 0.04 unit less than that of ordinary chlorine, and this gives a difference of very nearly 0.1 unit between the heaviest and lightest fractions, or a difference of about one part in 355, by far the highest relative change in atomic weight yet achieved. Other entirely independent separations have been carried out with the help of Anson Hayes, with T. H. Liggett, and with H. Mann.

Separation of Mercury into Isotopes

The separation of mercury into isotopic fractions is much simpler and easier than the similar work with chlorine, on account of the ease with which mercury vapor is condensed to a liquid. However, the separation of 0.12 unit of atomic weight, represented by the specimens, gives a relative change of atomic weight of one part in 1666, which is much smaller than that obtained for chlorine. The mercury exhibited was produced by diffusion through filter paper in work with R. S. Mulliken and Bernard Mortimer. With the assistance of S. L. Madorsky an entirely independent separation was carried out by diffusion through the surface of the mercury itself, that is, by vaporization at low pressure.

About 200 pounds of mercury, as compared with nearly a ton of chlorine has been used in the diffusions. Mercury is put in the flask and heated by a very large Meker burner. The atoms of mercury jump out of the surface into the vacuum above. In this process more of the lighter than of the heavier atoms of mercury escape. The atoms shoot upward into the tube of filter paper. The lighter atoms diffuse more rapidly through the filter paper, and then strike the glass surface cooled by water. The atoms collect and run down and out through an exit tube which consists of a capillary of more than barometric height. The mercury which runs in a constant stream out of this tube is from 25 to 30 parts per million lighter than the mercury which remains in the flask. Since the lighter mercury escapes, that in the flask continually grows heavier. As the mercury is separated its density is determined by a pycnometer of special design which without great care, gives the density to 1 part in two million, with care, probably to 1 part in 5 million.

Determination of the Atomic Weight of the Isotopic Chlorine

In order to prove with certainty that the atomic weight of chlorine has been changed by the various diffusions, three methods have been used. In one the titration value of aqueous solutions of ordinary and isotopic

chlorine of the same density, have been proved to be different; in a second method, silver chloride was precipitated and filtered through a platinum mat in a platinum crucible, and in a third, a known weight of the purest silver was dissolved in nitric acid in a quartz flask. An excess of hydrochloric acid was then added, the volatile material was evaporated off, the chloride fused and finally weighed in the same flask on a balance which gave a deflection of five tenths of a scale division for a hundredth of a milligram. Atomic weight determinations with ordinary chlorine gave 35.458, 35.459, 35.455, 35.456, 35.456, 35.458, 35.459, 35.459, 35.455, 35.459, 35.458, with a mean of 35.4576, which is in exact agreement with the best determinations of the atomic weight of ordinary chlorine. Determinations by this method of the atomic weight of the lightest chlorine exhibited gave 35.415, 35.417, 35.419, 35.417, 35.419, 35.419, with a mean of 35.4177, or 0.039 unit of atomic weight less than ordinary chlorine. The exactness of the results proves conclusively that the atomic weight has been affected The atomic weight of the heaviest chlorine is 35.515.

Purpose of the Development of Methods for the Separation of Elements into Isotopes

The only methods which have thus far served to separate isotopes are diffusion methods. A proper centrifugal method should separate them, and this method has been tried, but not under the best conditions, in this laboratory. An optical method seems to give some promise of success and will soon be tried.

The difficulties of separation are so great, and the differences between isotopes so small, that no strictly commercial uses for isotopes can be foreseen. Though the diffusion methods are very slow, they have now been developed sufficiently to indicate that moderately pure isotopes could be secured by a sufficient investment of money.

FURFURAL

THE MINER LABORATORIES, CHICAGO, ILL.

Although furfural was discovered a hundred years ago, it has until recently remained one of the rare organic chemicals, high in price and available only in small amounts. It was studied merely in its relations to "pure science" and but little thought or effort expended on its possible industrial application.

Through the application of chemical research, it has been found possible to manufacture furfural from oat hulls at a sufficiently low cost to make it the cheapest aldehyde available. After exhaustive study of various factors influencing the yield of furfural from oat hulls, such as time, acid con-

centration, rate of removal, etc., a simple and effective procedure was developed in which the hulls are subjected to the action of steam and acid in large rotary digesters. The distillate from these digesters, which has a relatively high furfural content is neutralized and furfural recovered by distillation. The liquor obtained from the still contains about 95 per cent furfural and 5 per cent water. This product is refined to between 98 per cent and 99 per cent and constitutes the technical grade of furfural on the market at the present time.

. Furfural is very active chemically, is a solvent of wide application and possesses many properties tending to give it commercial utility. It is at present being used very extensively in the manufacture of synthetic resins and molding compounds. As a solvent it is being used in the preparation of cellulose ester lacquers and in varnishes. A number of the synthetic resins made from it are adaptable to use in the varnish industry.

Because of its germicidal and fungicidal properties, furfural is finding application in the preparation of dextrin and similar pastes, also in glue solutions as well as in disinfectants, deodorizers, etc. Furfural solutions are extremely well adapted for the preservation of biological specimens.

The commercial use of furfural as a base for dye stuffs has been studied only slightly. Many compounds have been mentioned in both patent and scientific literature as dye stuffs, but to date none have been produced on a commercial basis.

LATEX SPRAYED RUBBER

UNITED STATES RUBBER CO., NEW YORK, N. Y.

Latex is the term used in the rubber industry to designate the milky fluid which flows from the inner bark of the rubber tree after it has been tapped. This latex is developed in a system of small tubes or cells lying between the bark and the wood of the tree. It is an emulsion of particles of rubber each about 1/25,000" in diameter held in suspension by the protective colloidal action of a small percentage of proteins.

Latex Sprayed Rubber is the name given to a form of rubber in which the rubber is manufactured from latex by atomizing the liquid into a slowly moving current of hot air or gas. This process was invented by Ernest Hopkinson, head of the Development Department of the United States Rubber Company.

Two methods of extracting rubber from latex have heretofore been in general use in rubber-producing areas: (1) In the Brazilian area the native worker dips a wooden paddle in the latex and holds the wet end of the paddle in smoke arising from burning leaves and nuts. This smoke has an astringent action and coagulates the rubber contained in the latex.

When the layer of rubber is coagulated and the water content has partially dripped off and partially evaporated, he dips again and continues the process until a large ball is formed. (2) In the plantation area in the East the rubber particles are coagulated by adding a dilute solution of acetic acid to the latex, the coagulum is removed from the remaining liquid or serum, washed, sheeted, and finally dried either with or without smoke depending on whether the final product is to be the commercial crude known as pale crepe or smoked sheet.

Ever since rubber manufacture took its place among the staple American industries in the early forties of the last century, manufacturers of rubber goods have had as their greatest problem a lack of uniformity in supplies of crude rubber from different sources. This was true throughout the period when the chief source of supply was Brazilian and other forms of wild rubber—uniformity was hardly to be expected where crude rubber was produced under these most primitive conditions. But even when the plantations with their vastly improved methods became the chief source of rubber supply, lack of uniformity, although improved, still persisted, to the despair of the manufacturer. The Hopkinson process produces crude rubber that meets every requirement of the manufacturer as to uniformity and at the same time gives him a rubber with tensile and other qualities better than regular plantation grades.

Under the Latex Sprayed Rubber method of manufacturing rubber, decomposition is immediately arrested and through the fact that the crude rubber produced is completely dried during the process, protein deterioration is prevented. Hence there is complete uniformity in the crude rubber as it reaches the factories.

In the sprayed process the latex is fed upon a rapidly revolving, horizontally mounted disc, from which it is thrown in an umbrella-shaped spray or mist, into a heated current of air or gas. The disc is located at the top of a high chamber, generally of the shape of a hollow pyramid, and the fine spray of rubber globules falling through the hot gases settles on the bottom of the unit as a dry, creamy white, spongy mass which has approximately one-third the density of ordinary crude rubber. A current of hot air is forced in at the top of the chamber, passes down through the spray or mist of latex and escapes at the outer edges of the bottom of the unit carrying away with it the water content of the latex. The rubber globules are dried instantly and the rubber shows no harmful effect whatever from the heat required for evaporation.

In general, as used on a commercial scale in the factories of the United States Rubber Company, this product shows very marked superiority in all essential respects over the standard grades of plantation rubber heretofore manufactured. Its behavior in the presence of zinc oxide is remarkable, giving a product of very high tensile strength with excellent aging prop-

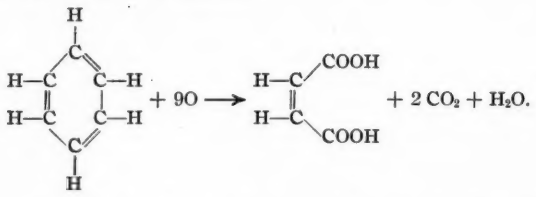
erties. The time of vulcanization of the sprayed rubber is much shorter than that required for standard grades. This is true in connection with all technical mixings. In general, an increase of over 30 per cent in tensile strength is obtained over the same compound made with pale crepe or smoked sheet. This high tensile strength is maintained both in the freshly vulcanized compound and in aging over all ranges of vulcanization periods. This superior quality persists in connection with stretch, abrasion, and permanent set of commercial articles made from this product.

CATALYTIC OXIDATION OF BENZENE TO MALEIC ACID

WEISS & DOWNS, NEW YORK, N. Y.

The process comprises the partial oxidation of benzene, in the vapor phase, by air, using vanadium oxide as a catalyst. It has been carried through the laboratory, experimental plant, and pilot plant stages and up until the time the inventors severed their connection with the interests to which the patent rights had been assigned, about 50,000 pounds of maleic acid had been produced and disposed of in the form of one or another of its derivatives. It is interesting to consider in this connection that prior to the development of this process maleic acid was merely a laboratory curiosity. It was derived by tedious processes from certain plant or fruit juices and, if sold at all, commanded prices approximating $50.00 per pound. Although maleic acid and its stereoisomer, fumaric acid, to which it is readily converted, have since the day of Kekulé been objects of interest to research workers in pure chemistry owing to their stereoisomeric relations, yet it is doubtful whether all laboratory workers together ever had collectively as much as 10 pounds of maleic acid up to the time of the perfection of this new synthesis.

The main chemical reaction taking place in this synthesis may be graphically represented as follows:



There are also certain side reactions resulting in the formation of formaldehyde, benzoquinone, carbon monoxide and excess carbon dioxide and water. The reactions involved are highly exothermic; that repre-

sented by the preceding equation liberating 10,560 B. t. u. per pound of benzene converted. Carbon dioxide and water over and above that shown in this equation are formed by the complete combustion of the benzene. When such complete combustion takes place there are 18,100 B. t. u. liberated per pound of benzene reacting. The instant removal of the heat of reaction is absolutely essential to obtain economical yields of maleic acid; otherwise complete combustion results and this reaction is not reversible. For this purpose even laboratory apparatus must be very carefully designed. The yields of maleic acid obtained in the ordinary hot tube apparatus used in high temperature synthesis in the past are very small. This difficulty is naturally magnified many fold when an attempt is made to transfer such a reaction from the laboratory-size reaction chamber producing a few grams of an organic product per day to a commercial scale where hundreds of pounds must be made. Without such commercial equipment, compounds like maleic acid would still be classed as rare chemicals. This difficulty was solved by the use of boiling mercury to maintain a temperature uniform over extended periods of time as well as uniform at all points throughout a reaction zone. With this equipment, any increase in the violence of the reaction liberating heat immediately results in boiling more mercury without change in temperature and the desired temperature is governed by the pressure arbitrarily applied to the boiling mercury. Practical yields of maleic acid amounting to 75 parts of acid per 100 parts of benzene fed to the oxidizer have been obtained and there is little doubt in the minds of the inventors that these yields are still capable of considerable improvement.

Maleic acid is a white crystalline solid melting at 130.5°C. and decomposing on distillation into maleic anhydride and water. It is soluble in water to the extent of 79 parts per 100 parts of water at 25°C. and is relatively insoluble in benzene and carbon tetrachloride. So far no uses have been developed for the acid *per se* except as a raw material for the synthesis of other products. It is extremely corrosive to metals but certain cheap alloys have been found to be satisfactorily resistant.

Maleic anhydride obtained from the acid by distillation under suitable conditions is a white solid melting at 52.6°C. and boiling at about 200°C. It is soluble in organic solvents while with water it is hydrated to form maleic acid.

By warming a solution of maleic acid with the addition of a small amount of a mineral acid it is transformed into its stereoisomer, fumaric acid, which separates, due to its sparing solubility. (0.7 part per 100 parts of water at 25°C.)

When hydrogenated, maleic and fumaric acids are changed to succinic acid. This may be easily accomplished by catalytic reduction using hydrogen and nickel. By various other reactions it is possible to produce a

large number of the straight chain organic acids such as tartaric, propionic, asparic, lactic, acrylic, etc. By condensation reactions, thiophene and pyrrol are readily obtainable. A whole series of new raw materials become commercial possibilities and the various possible ramifications are quite large.

CHEMICAL ACHIEVEMENTS OF THE U. S. DEPARTMENT OF AGRICULTURE

The Use of Ethylene in Hastening the Coloration of Citrus Fruit

Oranges and lemons which are ripe enough for the market are not always yellow all over. Citrus fruits may be commercially mature and still have a green surface color. Therefore the yellow color, if immediately desired, must be brought out by some special treatment.

Storing the fruit in boxes under suitable conditions produces the yellow color in a month or two. Many years ago it was found that this period could be cut down to a week or so by placing a kerosene stove in the room containing the fruit and properly adjusting the flame. Sievers and True showed that the increased rate of change was caused by the gaseous combustion products, the identity of the gas mainly responsible being at that time unknown.

The kerosene-stove method was unsatisfactory in so many respects that the Bureau of Chemistry undertook a series of experiments to determine the nature of the effective gaseous constituent. The results indicated that the coloration was caused by traces of ethylene in the air of the storage room.

The availability of pure ethylene in commercial quantities as a compressed gas in cylinders permitted a practical application of the results of this investigation. A mere trace of ethylene is sufficient to turn fruits from green to yellow.

As a result of the Bureau's investigation, the ethylene method is rapidly replacing the kerosene-stove method, over which it has the following advantages: Greater convenience; reduction of fire risk; no need for constant supervision; no exposure of workmen to the foul-smelling, tear-compelling atmosphere generated by stoves; no sooting or absorption of odors by the fruit; no wilting and shrinking of the fruit during the warm season; rigid standardization of temperatures, humidities, and gas concentrations, which insure uniform results.—U. S. Bureau of Chemistry, Washington, D. C.

The Catalytic Air Oxidation of Vapor Phase Naphthalene to Phthalic Anhydride

The shortage of phthalic anhydride and its derivatives during the World War led Gibbs and Conover, then of the Color Laboratory staff, into an

investigation of the then prevailing method of oxidizing naphthalene by the use of sulfuric acid in the presence of a mercury salt. The results obtained were very disappointing and led these investigators to take up the catalytic air oxidation process, using various oxides as catalysts, which Gibbs had previously used in oxidizing toluene in the vapor phase to benzaldehyde and benzoic acid.

The results obtained from mixing naphthalene in the vapor state with air and passing this mixture over either vanadium oxide or molybdenum oxide heated to approximately 500°C. soon indicated the presence of an appreciable amount of phthalic anhydride in the reaction products. Out of a large number of oxides later tested out as catalysts the two mentioned above proved to be superior to the others tried, the advantage resting with vanadium pentoxide.

The demand for this highly important intermediate, which has already been used in the preparation of about two hundred compounds, has been continually on the increase, last year's production in the United States being approximately four million pounds.

Owing partially to war-time conditions and partially to difficulty of manufacture under the old process, phthalic anhydride sold in 1916 in small lots for as much as fourteen dollars per pound, while today it sells for about twenty cents per pound.—U. S. Bureau of Chemistry, Washington, D. C.

Invertase

The principal advantages of inversion of sucrose in commercial practice are as follows: (1) Increase in solubility of total sugars, thus making it possible to prepare a non-crystallizing sirup of increased density; (2) retarded drying of such products as fondant confections and icing due to presence of levulose; (3) formation of smaller crystals, thereby improving the consistency of fondant confections, icings, etc.; (4) modification of flavor.

The enzyme invertase is more suitable than acids for the inversion of products such as sugar cane, maple, and sorghum sirups, "la cuite" and sirups prepared from raw or other low grade sugars which exert considerable buffer action toward acids and which require such amounts of acids as to unfavorably affect flavor—also for manufacturing golden sirup by direct inversion of an intermediate refinery sirup. The latter is a more direct process than that customarily used which consists in inverting granulated sugar sirup with acid and mixing same with refiners' sirup. The use of invertase in maple cream (a fondant prepared from maple sugar or sirup) makes possible the production of a smoother fondant (smaller sucrose crystals) of more homogeneous consistency.—U. S. Bureau of Chemistry, Washington, D. C.

Fumigation of Grain against Weevils

Weevils destroy many million dollars worth of wheat and other grains annually. Carbon disulfide is extensively used as a fumigant against these insects but on account of its ready inflammability and the explosibility of a mixture of its vapor with air, fire insurance companies refuse to carry the fire risk on elevators or buildings during the time carbon disulfide is being used to treat the grain contained in them. Owing to this fact, and also because no effective substitute for carbon disulfide for fumigating purposes was known, the General Managers' Association of Chicago, representing the leading railway systems of the United States, requested the United States Department of Agriculture to undertake an investigation having as its object the development of a substance which could be used for destroying weevils in grain with safety from fire hazard.

In compliance with this request, the Bureau of Chemistry, in coöperation with the Bureau of Entomology, tested the action of more than 100 organic compounds on the rice weevil, the granary weevil, the flour weevil and the Indian meal moth under conditions permitting a control of the factors of concentration, time, and humidity, and with observations of the temperature. While about 30 compounds were found to be more toxic than carbon disulfide to the rice weevil, under laboratory conditions, fumigation tests against this weevil when present in wheat in boxes, barrels, and railway box cars eliminated all economical fumigants except ethyl acetate. In order to reduce the fire hazard which would result from the use of ethyl acetate alone, it is mixed with carbon tetrachloride in the ratio of 35 to 40 volumes of ethyl acetate to 65 to 60 of carbon tetrachloride. This mixture has been carefully tested under practical fumigating conditions in box cars and grain elevators, and when used at the rate of 40 to 45 pounds per 1000 cubic feet of enclosed space is effective in killing all weevils. It is non-inflammable and the vapor of the fumigant in mixture with air is not explosive at temperatures up to 120°F. This fumigant has a pleasant odor and is not injurious to those handling it. It does not lower the germinating quality of seeds and the quality of flour and bread from wheat which has been treated with this fumigant is not injured. The fumigant, ready mixed, is now obtainable at a price which figures to less than 1 cent per bushel of fumigated wheat when applied in an elevator. The method of applying the fumigant is identical with that used with carbon disulfide. Great benefit will result to those producing and handling wheat and other cereals from this development of a fumigant which can be used without voiding the fire insurance on the buildings used to contain the grain. The results to this investigation in detail are given in U. S. D. A. *Bulletin* No. **1313**, January 26, 1925.—U. S. Bureau of Chemistry, Washington, D. C.

Products from Plants

The products exhibited by the Phytochemical Laboratory were selected with a view to representing some of its more notable achievements. The purpose of the respective investigations and the results obtained are very briefly noted.

Caffeine.—During the World War the material which had hitherto been available for the production of caffeine became very much diminished in quantity and new sources for this important organic compound were therefore sought. It had previously been observed that caffeine is contained in one of our native species of Holly (*Ilex vomitoria*) and a more extended investigation of the subject has shown that it would be possible to utilize the leaves of this plant for its production. Another source of caffeine that had not previously been considered is the pulp of the coffee berry. Although this material is accumulated on the coffee plantations in very large quantities, it has always been regarded as a waste product and suitable only for fertilizing purposes. In connection with this investigation a method was devised for the accurate quantitative determination of caffeine in holly leaves as well as in tea, coffee, and other plant products containing it.

The Odorous Constituents of Fruits.—It is only within recent years that anything has been known regarding the nature of the substances which impart to certain fruits their characteristic odors. An investigation of the apple has shown that its fragrant odor, and to a certain extent the flavor, is due to a complex mixture of substances, consisting chiefly of amyl esters and acetaldehyde together with a small proportion of geraniol or its esters. As a result of this investigation it was found possible to produce a synthetic apple oil which is well adapted for imparting to beverages, ice cream, etc., the characteristic apple flavor.

The odorous constituents of peaches have likewise been examined, and these have been found to consist chiefly of esters of linalool, together with a considerable proportion of acetaldehyde. An examination of a large number of authentic grape juices has established the fact that the odor of certain varieties of this fruit is due in part to the presence of methyl anthranilate and a method was devised for its detection.

The Odorous Constituents of the Cotton Plant.—The investigation of this subject was undertaken in order to ascertain the nature of the substance which is presumed to attract the boll weevil. In the course of this work, which extended over a period of nearly two years, a large number of definite chemical compounds were isolated from a distillate of the plant. Some of these substances had a very pleasant odor, but it was found that the distillate also contained appreciable amounts of ammonia and trimethylamine. It was furthermore ascertained that these two basic substances are constant exhalations of the plant. The results of this investiga-

tion will, therefore, form a basis for more extended entomological experiments in the control of the boll weevil.—Phytochemical Laboratory, U. S. Bureau of Chemistry, Washington, D. C.

Furfural

Research by chemists of the Bureau of Chemistry, U. S. Department of Agriculture, on the production of furfural has resulted in the development of a cheap and simple process for its manufacture from corncobs.

In brief the process consists in digesting the cobs with steam at about 135 lbs. pressure for approximately 2 hours, while distilling off slowly the furfural formed, and collecting it as a dilute aqueous solution. The latter is put through a column still provided with continuous decantation in order to separate the furfural in the form of a 95 per cent solution. Just enough sulfuric acid (about 0.75 per cent of the weight of cobs) is added with the charge to neutralize the bases present, and water is added in such quantity that with condensed steam the water–cob ratio 30 minutes after digestion begins will be about 4:1. At the end of the digestion the digestor contents are discharged, drained, washed, and pressed to separate the cellulosic residue and liquor. The liquor contains some furfural which is recovered as a dilute solution to be used in subsequent digestor charges. (For further discussion see Furfural, p. 1175.)—U. S. Bureau of Chemistry, Washington, D. C.

Manufacture of Phosphoric Acid by the Volatilization Process

The investigations of the Bureau of Soils on the pyrolytic treatment of phosphate rock date back to 1912. This work was undertaken as one phase of the problem concerned with the development and utilization of existing and new sources of fertilizer materials. The volatilization method of treating phosphate rock appeared to offer possibilities as a means, first, of conserving our phosphate deposits through the utilization of low-grade and run-of-mine rock, and, second, of producing phosphoric acid as such in a form best adapted for making concentrated fertilizer.

Volatilized phosphoric acid offers advantages over that prepared by the sulfuric acid method in that it is initially of higher purity and concentration; it can be more easily refined; transportation costs are lower; it can be used directly without concentration in the preparation of concentrated salts; and by crystallization it can be made to yield directly a higher grade product than can be produced by any other method.

Recent laboratory investigations have shown that phosphoric acid can be almost completely volatilized from mixtures of phosphate rock and coke, with or without the addition of sand, at temperatures of 1200° to 1300°C. with the production of an unfused residue. Investigations bearing on the

commercial possibilities of this low-temperature process are now in progress.—U. S. Bureau of Soils, Washington, D. C.

Improved Catalyst for Ammonia Synthesis

The catalyst may well be called the "heart" of the synthetic ammonia process. The development of the first technically suitable catalyst material, by the Badische Anilin und Soda Fabrik in 1910, established the foundation for the ammonia industry and at the present time the properties of the catalyst are dominant factors in the determination of ammonia production.

Experiments made so far show that no one metal possesses all the properties desirable in a practical catalyst. Distinct improvements have been effected, however, (1) by mixing certain active metals, and (2) by adding small quantities of apparently inert substances to catalytically active metals. During the war extensive investigations of the first method were made in English, French, and American laboratories. In these experiments the best results were obtained with a mixture made up of equal parts of iron and molybdenum. Since cheaper and better catalysts can be prepared by the second method of activation, this iron-molybdenum combination has never been employed in the commercial production of ammonia.

The results of experiments disclosed the fact that no single substance effected an improvement in the catalytic properties of iron even remotely comparable to that produced by a combination of two or more properly selected substances. The superiority of a properly selected multicomponent or composite promoter is evident from the following tests on three iron catalysts—one containing potassium oxide; a second, aluminum oxide; and a third a combination of both oxides. These tests were all made under strictly comparable conditions at 100 atmospheres, 450° and 5000 space velocity, that is, 5000 volumes of gas (N. T. P.) per hour per unit volume of catalyst. In these tests the iron catalyst containing only aluminum oxide gave 9 per cent of ammonia by volume in the effluent gas, while the one containing potassium oxide gave 4 per cent. When potassium oxide and aluminum oxide in the form of potassium aluminate were added to the iron, the resulting combination produced a catalyst giving 14 per cent. Composite promoter combinations of other basic and acidic oxides were found to give desirable results.

It will not be possible to discuss the various forms of iron oxides which might be employed and their methods of preparation. It is sufficient at this time to state that an artificial magnetite has been found to give the most satisfactory results. The problem of preparing an oxide is, therefore, one of fusing iron oxide and the promoter under such conditions that the chemical composition of the oxide mixture may be rigidly controlled. On

account of the great chemical reactivity of fused iron oxide it cannot be melted in any crucible so far developed. Many refractory materials have been investigated for this purpose, but all have been found to contaminate the molten oxide. The method finally adopted consists in fusing the oxide in a protecting bed of the same material. The electrical conductivity of the oxide is sufficiently great so that the material may be melted between water-cooled iron electrodes. Promoters are readily added to the iron oxide in this method of fusion, and all those substances which are known to react unfavorably can be carefully excluded.—Fixed Nitrogen Research Laboratory, Washington, D. C.

ERRATA

Vol. **2**, No. 9, p. 733, first paragraph.—The fifth sentence should read as follows: "Of what use is our research, our study of technical trivialities, while souls are scorching, athirst for the sustenance which real knowledge can give?"

P. 735, next to last paragraph.—"It is useless to insist. . . ." should be, "It seems to be useless. . . ."

No. 11, p. 1066.—The Latin quotation should read: *Usus Decimalium numerorum. Mensurae & pondera diuidantur in 10, partes aequales, & singulae decimae rursum in alias aequales 10, quae iam erunt centesimae totius: Atque harum singulae iterum in 10, quae proinde iam erunt millesimae totius.*

CHEMISTRY IN INDUSTRY

Through the courtesy of the Chemical Foundation, Inc., several sections of the American Chemical Society earned a few dollars for local expenses through the sale of "Chemistry in Industry," Volume I. This book is mailed to individuals for one dollar but if lots of one hundred are ordered sent to a single address a saving in packing and postage enables the Foundation to make a price of $75 for the lot.

Volume II is now available on the same basis. The two books give 43 examples of chemistry in the service of industry, each chapter written by a specialist in the field. Many teachers of chemistry require their students to own these volumes for supplementary reading and reference. In purchasing a lot and disposing of them a local section or a teacher of chemistry is performing a constructive service in thus aiding in the dissemination of chemical information.

A lot of one hundred of Volume I or of Volume II may be had for $75, or the two volumes mixed in whatever proportion may be wanted can be had at the rate of $75 per hundred sent to a single address. Any orders should be sent to the Committee on Prize Essays, Paul Smith, Secretary, 85 Beaver St., New York, N. Y.

HOW WE TEACH FRESHMAN COLLEGE CHEMISTRY

B. CLIFFORD HENDRICKS, UNIVERSITY OF NEBRASKA, LINCOLN, NEBR.

A committee of the Chemical Education Division of the American Chemical Society is seeking to formulate and, perhaps, hopes to somewhat standardize a minimum course for beginning college chemistry.[1] Cornog and Colbert have studied the content of beginning courses as revealed by the texts and examination questions used.[2] Any attempt at standardization will need, not only to consider content, but the administrative aspect of the subject as well. It is with this phase of the problem that the present paper is concerned.

In the spring of 1924 a questionnaire was sent to seventy colleges and universities seeking information in regard to credit for the first year chemistry course, the laboratory and quiz requirements, time given to lectures, number of students registered, their distribution for laboratory, quiz, lecture, etc.[3] Thirty-seven replies were received, representing a beginning chemistry student body of over 17,000 of which over 12,000 were starting the study of the subject for the first time.

The Distribution of the Student's and the Instructor's Time

In the tables which follow data upon two different types of courses are given: first for a course, called "A," for those students who have entered college with less than two semesters of high-school chemistry and second, a course, "B," for students who have had the standard two semesters of high-school chemistry. Forty-three per cent of the thirty-seven schools have a distinct course for these latter students and a number of others have special quiz or laboratory arrangements for them. Results from the replies have been reduced to values relative to the semester-hour credit in order that the cross comparisons may be the more readily made.

An inspection of the table shows that relatively more time is given to lectures for the "B" group of students than to the "A." A little less than fifty per cent of the colleges give one-half hour or more lecture time per week per semester-hour credit for the "A" group while *more* than fifty per cent of them give that much lecture time for the same credit for the "B" group. It is also evident that more *lecture* time per credit hour is given to both groups than *quiz* time; sixty per cent of the colleges give the "A" groups three-tenths hour or *less* per week of quiz time per semester-hour of credit and sixty-two per cent give that treatment to the "B" groups. Some schools reporting indicate no marked distinction between lecture and quiz time. A combination of these shows sixty-two per cent of the colleges

[1] THIS JOURNAL, **1**, 93 (1924).

[2] *Ibid.*, **1**, 5 (1924).

[3] Doctor Cliff S. Hamilton collaborated with the author in preparing and in sending out the questionnaire.

TABLE I

TIME COST OF ONE SEMESTER-HOUR CHEMISTRY CREDIT

Hours per week per semester hour		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
1. Lecture hours per sem.-hr. credit	A	...	10.8*	21.6	18.9	18.9	16.2	10.8	2.7	...	..	...	..	..
	B	...	12.5**	25.0	12.5	6.3	12.5	31.2	..	...	..	...	..	..
2. Quiz hours per sem.-hr. credit	A	2.7	24.3	35.2	24.3	5.4	..	2.7	2.7	...	..	...	..	..
	B	...	25.0	37.5	12.5	6.3	..	12.5	..	...	..	...	..	..
3. Combined quiz and lecture hours per sem.-hr. credit	A	...	..	2.7	2.7	13.5	5.4	13.5	37.8	...	24.3	...	..	..
	B	...	..	..	6.3	..	18.8	6.3	31.3	...	37.5	..	..	..
4. Laboratory hours per sem.-hr. credit	A	...	..	..	..	2.7	8.1	10.8	16.2	5.4	35.2	...	10.8	8.1
	B	...	..	..	..	6.3	6.3	25.0	6.3	...	31.3	...	12.5	..
5. Home study hours per sem.-hr. credit	A	...	..	..	..	..	..	2.7	2.7	2.7	21.8	2.7	5.4	10.8
	B	...	..	..	..	..	..	..	6.3	...	37.5	...	12.5	6.3
6. Total student hrs. time per sem.-hr.	A	...	..	..	..	..	..	..	..	...	..	...	..	..
	B	...	..	..	..	..	..	..	..	...	..	...	..	..
7. Hours of instructor's time per sem.-hr.	A	...	..	..	..	..	..	..	..	...	..	...	..	..
	B	...	..	..	..	..	..	6.3	..	...	6.3	6.3	..	6.3

TIME COST OF ONE SEMESTER-HOUR CHEMISTRY CREDIT (*Continued*)

Hours per week per semester hour		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4	2.5	2.6–3.0	3.1–3.5	3.6+
1. Lecture hours per sem.-hr. credit	A	..	..	..	..	..	..	..	...	...	...	..	..	...
	B	..	..	..	..	..	..	..	...	...	...	..	..	...
2. Quiz hours per sem.-hr. credit	A	..	..	..	..	..	..	..	...	...	...	..	..	...
	B	..	..	..	..	..	..	..	...	...	...	..	..	...
3. Combined quiz and lecture hours per sem.-hr. credit	A	..	..	..	..	..	..	..	...	...	...	..	..	...
	B	..	..	..	..	..	..	..	...	...	...	..	..	...
4. Laboratory hours per sem.-hr. credit	A	..	2.7	..	..	..	..	..	...	...	...	..	..	...
	B	..	6.3	..	..	..	..	..	...	...	...	..	..	...
5. Home study hours per sem.-hr. credit	A	2.7	8.1	5.4	..	..	..	..	...	...	...	..	..	...
	B	6.3	..	..	..	..	..	..	...	...	...	..	..	...
6. Total student hrs. time per sem.-hr.	A	..	..	..	..	..	..	..	...	5.4	5.4	32.4	18.9	2.7
	B	..	..	..	..	..	..	12.5	...	6.3	...	43.8	6.3	6.3
7. Hours of instructor's time per sem.-hr.	A	16.2	10.8	18.9	5.4	24.3	..	18.9	5.4	...	...	..	..	...
	B	6.3	6.3	6.3	12.5	12.5	..	31.3	...	...	...	..	..	...

* This says that 10.8% of the thirty-seven colleges give only 0.2 hour lecture time per week for each semester hour of credit for students who have had no high-school chemistry, *i. e.*, course "A."

** This means that 12.5% of these colleges give 0.2 hour lecture time per week for each semester-hour credit for the students who have had two semesters of chemistry from an accredited high school, *i. e.*, for course "B" students.

affording their "A" groups eight-tenths or more class-room hours per week for the unit credit and sixty-nine per cent giving the "B" groups that much attention.

In the laboratory, however, the order is reversed, the "A" groups having the lead with fifty-seven per cent of the institutions giving them one hour per week per credit hour against only fifty per cent of the schools reporting that much laboratory time for the "B" students.

Reports upon hours of home study were incomplete so the tabulation, as it stands, is fragmentary. It does, however, indicate approximate practice in the institutions which reported. The most significant fact shown is the number of hours the student is expected to use for each hour credit. Over 20 per cent of the schools require in excess of three hours per credit hour from their "A" group students and 12.5 per cent require that number of hours from their "B" group students. It would seem that they expect those having had high-school chemistry to earn credit with less work.

From the standpoint of instruction cost, the seventh item in the table is of most interest. It is to be noted that 84 per cent of the schools give their "A" group one and one-half hours or more of the instructor's time for each credit hour and 69 per cent of them give the "B" group one and one-half or more hours for that credit. In this the balance favors the "A" groups.

Distribution of the Teaching Load

From the previous table we are prepared to expect a distribution of the large lecture groups into smaller groups for quiz and laboratory instruction. There yet remains the question as to the size of these groups. The following table helps to answer this.

From these figures it is seen that the reports are from our larger colleges, eighty per cent of them registering more than 150 students in the beginning chemistry courses. Also, that over fifty per cent of them handle their students in lecture sections of 100 or more students.

The most usual-sized quiz group has been thirty and thirty-four students with more than fifty per cent of the colleges having the quiz group that size or larger. A very common comment, is, however, that there is a need for smaller-sized quiz sections.

The most common size for the laboratory section is between twenty and twenty-nine, though about one-fifth of the institutions have their laboratory sections smaller than twenty students.

What Credit for the First Semester of College Chemistry?

The college deans, or administrators in general, wish to know what fraction of a freshman's student load is to be chemistry.

had two semesters of chemistry from an accredited high school, *i. e.*, for course "B" students.

TABLE II

REGISTRATION IN CHEMISTRY AND SIZE OF QUIZ, LABORATORY AND LECTURE SECTIONS*

	Course taken	The number of students in the group												
		10–19	20–29	30–34	35–44	45–70	71–84	85–99	100–149	150–199	200–249	250–299	300–349	350+
1. Registration in chemistry.	A	..	..	..	2.8**	2.8	..	8.4	5.6	14.0	5.6	11.2	14.0	35.6
	B	..	..	18.8	..	6.3	..	6.3	18.8	6.3	6.3	..	6.3	12.5
2. Size of lecture sections....	A	..	..	2.7	..	16.2	10.8	10.8	21.6	13.5	13.5	5.4	5.4	..
	B	..	..	←12.5→		..	12.5	..	37.5	18.75	6.25	..	..	..
3. Size of quiz sections.....	A	8.1	29.8	43.2	2.7	5.4	..	..	..	2.7	..	..	..	..
	B	12.5	25.0	37.5	18.8	..	..	..	..	..	..	..	..	..
4. Size of laboratory group..	A	24.4	45.9	27.0	2.7	..	..	..	..	..	..	..	..	..
	B	18.8	37.5	31.3	..	..	..	..	..	..	..	..	..	..

* Some colleges failed to report upon some of these items so the total may sometimes be less than 100 per cent.

** This means 2.8 per cent of the institutions registered only 35 to 40 students in the fall of 1923 who had had less than two semesters high-school chemistry.

TABLE III

CREDIT THE STUDENT RECEIVES FOR FRESHMAN CHEMISTRY

Credit in semester-hours	3	3 to 4	4	4 to 5	5	6	Other values
For A group	11.1	..	38.9	8.3	27.8	5.6	8.3
For B group	43.8	12.5	18.8	1	12.5	...	12.5

Here, it is to be noted, the most common credit for the "A" group students is four semester hours per semester while three such hours is largely the credit given for the students who have had the year of high-school chemistry.

What the Present Standard Seems to Be

What is a typical college chemistry course for students entering with no high-school chemistry? From what has preceded, may it not be said to offer the student four semester hours of credit; put him in a lecture section with about 100 other students, in a quiz group of about thirty and in the laboratory sharing the instruction from one assistant with about twenty-five students? This student will probably have two hours of lecture per week, a trifle more than one hour of quiz per week, and four hours of laboratory.

For the student who has had two semesters of high-school chemistry there will be but three hours college credit for the first semester's course. There will be about two hours of lecture per week, less than one hour of quiz, and three hours of laboratory. His lecture section will have about 100 students and his quiz and laboratory sections about the same size as those for the beginning student.

These numbers indicate the prevailing practices of our larger institutions. Not only that, but forty-nine per cent of them say they are very well satisfied with such a plan of organization and of administration. Standards must recognize prevailing practices. The task, then, would seem to be that of converting the fifty per cent who have practices at variance with the more common to a nearer approach to uniformity. There are many values that can be advanced favoring such an effort.

20,000 Mile Sun-Spot May Affect Compasses.—Magnetic storms on the earth may be expected as a result of the flock of sun-spots now visible on the sun, and the needles of compasses on the earth may be affected, causing trouble in navigation, according to J. A. Fleming of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. These spots are now visible on the coelostat telescope used to display the sun to visitors at the National Academy of Sciences. According to attendants, this is the largest number of sun-spots seen at one time since the sun passed through its period of minimum activity about two years ago. The largest of the 17 visible spots is about 20,000 miles across.—*Science Service*

Correspondence

"CHEMISTRY AS DEPICTED IN ART"

The writer was much interested in the article, "Chemistry as Depicted in Art," in the February, 1925, JOURNAL.

He would cordially agree with the author regarding the alchemist pictures of Teniers and others, of which there are several scattered through the galleries of Holland, Belgium, and Germany. The original paintings, most of which the writer has seen, must have been true to life, and certainly have the alchemistic atmosphere. It is interesting to note that they took their books into the laboratory as do our students now.

The writer thinks the three modern allegorical pictures most disappointing and would not advise their purchase. Chavanne's "Chemistry" is represented as a thinly draped woman, with three children in the foreground, looking at a retort, heated on an old-time charcoal furnace, in the right lower corner. Were this replaced by a turtle, it could be equally well named "Children Watching a Tortoise." Its one obtainable size is $5^1/_2$ by 10 in. at $3.00.

Nor are the "Sciences" much more alluring: In a semi-lenticular picture, the central figure represents "Geography," a female toying with a pair of blackboard compasses and a globe. Astronomy is depicted as a youngster with a small, simple spy glass. Four others represent Mathematics, Physics, and some other sciences not evident. The size, two feet long, costs $7.50.

The picture of "Dalton Collecting Fire Marsh Gas" is not particularly attractive. It represents a group of youngsters and a cow, watching Dalton stir up a pool, which might well be covered with ice, with the bubbles being caught by a youngster. The size is 4 by 10 inches and the price 5 shillings.

Lest it may be said that the writer has no idea of art, and has had no opportunity to study it, he would say that he has spent eight or nine months at different times in travel and art study in Europe and America. He has seen most of the important galleries of Europe, except those in Russia and Spain, spending days or even weeks in some of them.

A. H. GILL

M. I. T., CAMBRIDGE, MASS.

CORRESPONDENCE COURSES IN CHEMICAL ENGINEERING

The following inquiry comes from one of our readers who has no access to evening or part-time university courses:

A copy of your JOURNAL came into my possession recently through the kindness of a friend and after reading it I have decided to write to you for information in reference to the study of chemistry.

I have about completed the study of a correspondence course in "Chemical Engineering" as offered by a well-known commercial institution of learning and, while it is not my intention to "knock" this, I feel that it leaves much to be desired in every way.

I am at present employed in the laboratory of a large manufacturing concern with ample opportunity to experiment and study. Beside this I may say that I am possessed of a fair education.

I believe that there are some excellent courses of instruction offered to those who cannot attend a college but have no definite information about them. Will you, then, give me the benefit of your advice as to how to proceed or to whom I should apply for the information?

Knowing that the University of Chicago conducts some extension work in chemistry, we referred the letter to Dr. Stieglitz of that institution. His reply follows:

The University of Chicago gives a few elementary courses in chemistry by correspondence. They include general chemistry, qualitative analysis, and elementary organic chemistry. There is no thought whatsoever of giving work in "chemical engineering." Neither my experience nor that of Miss Johnson in the correspondence study department of the University could be the basis of an answer to your correspondent.

Perhaps some of our readers know of courses which they can conscientiously recommend.

SUMMARY ON ATOMIC STRUCTURE

Recently one of our correspondents wrote us as follows:

I intend to take advantage of your "Correspondence" department, as described on page 937 in the October issue, and I shall certainly be indebted to you for your help in obtaining this information.

Briefly, the problem is this: I am teaching chemistry in a private school in this city. I am greatly interested in the electronic theory of matter, its relation to the periodic table, etc. I have read a great many texts on the subject, and I want to give my students a brief summary of the whole situation, not to exceed 500 words or so. The text we use is Brownlee, Fuller, and others, "First Principles of Chemistry" and the subject is very sparsely treated. Do you think that I might obtain a summary of the situation as described above?

The inquiry was referred to Dr. M. S. Kharasch, of the University of Maryland, who has made a thorough study of the literature on this subject, and we received the following reply:

I am not acquainted with any text which covers the electronic theory of matter in its relation to the periodic system in 500 words. In this field, for the time being, everyone has to do the digesting for himself and I would recommend that the correspondent read the following books and papers: Millikan, "The Electron;" Moseley, *Phil. Mag.*, **26,**

1024 (1924); Lewis, *J. A. C. S.*, **38**, 762 (1918); Langmuir, *J. A. C. S.*, **41**, 868 (1919); and Lewis, *Valence*, Monograph of the A. C. S.

Since then, an article entitled "The Structure of the Atom," by Phillips H. Abright has appeared in the November number of *School Science and Mathematics*. This article is about 2000 words in length and contains a few mathematical expressions unintelligible to elementary pupils. It is, however, popularly written in the main and could be easily revised to eliminate equations. Professor Abright's paper furnishes the most concise summary that has come to our attention.

We would be very grateful for any additional suggestions from our readers:

HOMELY ILLUSTRATIONS

The following queries, submitted to DR. F. E. Brown of Iowa State College, and his answers thereto are published in the hope that they may prove interesting and helpful to our readers:

Q. Do you use stories and illustrations in teaching chemistry? From what sources do you get your stories? Will you tell me some of the illustrations which you use?

A. Yes, I tell stories and use homely illustrations in almost every class-period. I use them to make abstract ideas vivid, to keep up the interest of the class, to arouse those who show signs of drowsiness, and because I like to tell stories.

If possible, I draw my illustrations from recent happenings of general interest, or at least from situations so well-known to the entire class that the illustration does not need to be explained.

Saturation of Solutions

Several years ago some of the instructors who were working with me told me that "supersaturated solution" was an idea too difficult for freshmen to comprehend, and suggested that I refrain from asking my pupils to define it in examinations. Instead, I composed the following story and we now have less difficulty with "supersaturation" than with many other ideas.

Johnny's mother made Johnny fill the wood box every night after school. On one particular night when Johnny was feeling imposed on, as boys do, he decided to show his mother how much she made him do by carrying only two or three sticks at a time. Of course, he might have carried more at any time but he did not, unless he found a stick right at the door. He couldn't help taking advantage of such a situation so he picked up any sticks which needed to be carried only a short distance.

The box was less than half-full when Billy appeared with his sled and shouted, "Johnny ask your mother to let you come and slide down hill with me." Mother said "When the wood box is full." Billy could not enter the house for his boots were muddy, but Johnny found that he could carry twelve sticks each trip. However, he could not pick up even one stick of the load which Billy had brought to the door without dropping one which he already had. He tried it repeatedly but was able to pick up and hold only a dozen sticks.

Finally Billy had a bright idea. Johnny brought twelve sticks to the door, and Billy

brought twelve. Johnny stood upright and Billy piled his twelve on Johnny's extended arms. Then Johnny carried the twenty-four sticks into the kitchen. If Johnny picked up one stick, now thirteen fell but as long as he merely held what he had, he could keep all twenty-four, though he could pick up only twelve.

The answers on my examination papers read: "A super-saturated solution is a solution which is *holding* more solute than it can *take up*."

As you readily see, the story is designed to illustrate unsaturation and saturation, and the tests for degree of saturation by offering the solution more solute, as well as supersaturation.

Catalysis

One day while I was sitting in a Santa Fe coach at Lawrence, Kansas, waiting for a branch line train to arrive, so that our train could go on west, I watched a section hand shoveling cinders into a flat car. He was alone. He seemed to have much trouble with his pipe. Between walking around the cinder pile and caring for his pipe he put just ten small shovelsful of cinders in the car in the first twenty minutes during which he was under my observation.

Then a small red-headed Irishman puffing on a short-stemmed cob-pipe came around the end of a string of cars hopped up on a pile of ties and sat there smoking. As long as the Irishman sat there, fifteen shovelsful per minute of those cinders went into that car.

The red-headed Irishman did not say a word, or do any work so far as I could see; but as long as he sat on that tie pile close to the cinder pile, the cinders went into the car thirty times as fast as when he was not there.

In railroading they call him a section boss. In chemistry it is a catalyst.

Q. I have no storeroom assistant and it takes all of my time handling apparatus so that my laboratory teaching is almost negligible. How can I improve this situation?

A. You should be able to convince your principal or school board that a part of the laboratory fees could be profitably spent in hiring a high-school student as a dispenser for the time at which the laboratories are in session.

If you cannot secure any funds at all for this purpose, arrange for the pupils to serve in rotation as store keepers and assign a correspondingly shorter assignment. For instance, in one school I had forty pupils in laboratory. I always had the supplies needed for any day, conveniently arranged. Then I made a schedule which put two pupils in the storeroom and thirty-eight in the laboratory. Nineteen assignments were made for each twenty laboratory periods.

The vast majority of pupils accepted the assignment as a trust and no trouble of any kind resulted. The storeroom window opened directly into the laboratory.

F. E. BROWN

Large Radium Deposits Found in Russian Turkestan.—Deposits of radium ore and other radio-active minerals have been found in the Fergana district of Russian Turkestan, in central Asia, by an expedition sent in by the government to prospect the reported finds. The members of the expedition state that the main vein lies on the northern slopes of the Altai mountains, about sixty miles east of the city of Fergana. The total wealth represented could not be exactly estimated, but it is certainly very great, and in the opinion of the explorers the radium, uranium, and other rare elements that can be produced by its exploitation will become a very significant part of the world supplies of radio-active materials.—*Science Service*

CLASS-ROOM EMANATIONS

Amphoteric is something that is got to be found out like an unknown.

Hydrolysis is a substance in a water solution like NaCl and you want to find out if it has intentions to go acid or basic.

An ore is a mixture of various metals. A mine is an example.

A native metal is a metal in his activities.

Acetaldehyde is an olemetic compound.

Metallurgy is distracting a metal from its ore.

Nitrogen is mined in the form of bismuth and antimony.

Hydrogen sulfide has a very discouraging odor.

In blast furnace practice, "furnace charge" is the electrical charge that is given the furnace.

Isomerism is the determining of the amount of heat units which may be obtained from a certain kind of coal.

Slag is the oily material which collects on top of the iron at the base of the furnace and is drawn off.

After precipitation is complete, saturate the solution with hot water.

Ordered at the stock-room: one cc.; tenth normal distilled water; bariometer; acidic acid.

An acid salt contains more solute than solvent.

Aqua regia is used in bleaching woolen cloth.

The electrochemical series arranges elements in the order in which they enter cells.

Sulfuric acid works very hard on salt and water.

Nascent atoms are equipped with arms, with which they can combine with other atoms.

Chlorine is a very dangerous gas; when inhaled deeply it causes intestinal trouble.

It is a known fact that chlorine contains two atoms of oxygen.

G. M. V. = General molecular volume.

G. M. V. = Grand molecular volume.

Anhydride is an organic acid containing carbon.

Anhydrous' law or hypothesis is that molecules combine with each other in such a way that there is no loss or gain in electrons.

Anhydride is a waterless base.

Every molecule contains 2 atoms, therefore one molecule of oxygen contains 2 atoms.

The animal body breathes in oxygen and breathes out noxygen. (Probably this is the reason some people are subject to more knocks than others.)

The Muscle Shoals Plant is found in almost any woods. It is something to eat.

Chemical Digest

THE PROPER TRAINING FOR GRADUATE STUDENTS PREPARING FOR PROFESSORSHIPS IN THE SMALLER COLLEGES

The following statements are taken from an article entitled "A Study of the Graduate Schools of America," by President Raymond M. Hughes of Miami University. President Hughes studied chemistry at Ohio State University and the Massachusetts Institute of Technology and was formerly professor of chemistry in Miami University. He has spent many years in an intensive study of the needs of the smaller colleges and has conducted a number of educational surveys in different states. He undoubtedly voices the general opinion of the different executives of colleges such as Miami and his views are therefore of general interest.

We (*i. e.*, Miami University), represent some 500 colleges of greater or lesser strength, financially and numerically, which are the chief employers of the products of the graduate schools of America. We absorb into our teaching staffs each year the majority of the men and women who are trained in our great graduate schools. This being the case, it seems to me that we might have some weight in influencing the policies of the graduate schools, at least to a small degree, so that the teachers who come to us from them might be somewhat better fitted for the work for which we employ them.

There are four distinct lines in which I think the graduate schools might serve us more effectively. In the first place, the large majority of the colleges of America are affiliated with the church, and are seeking men at least sympathetic with religion and preferably men with religious convictions and men whose own lives are definitely guided by noble religious ideals. I am under the impression that in many of our graduate schools there is little suggestion of interest in religious matters by men on the graduate school staffs, and I feel that the influence of the graduate schools is rather negative or perhaps positively unsympathetic to the religious point of view in many cases. Young men seem to lose rather than gain in their interest in religion in the graduate schools. I am thoroughly convinced in my own mind that no man should teach in an American college who is not sympathetic with religion and who has not developed his own religious ideals to such a degree that his life is guided by them. It seems to me that the graduate schools of America should at least make an effort to cultivate and strengthen the religious life of the graduate student. Many of the most distinguished scholars are men of the noblest lives and of deep religious feelings and convictions. I believe the graduate schools could easily contribute much to the growth of the graduate students in their religious sympathy and conviction.

In the second place, I feel there has been entirely too much of a tendency toward highly specialized study in the graduate schools. We in the colleges are looking for men of broad, sound training in their fields, generous interest in related subjects, rather than for men of a highly specialized training who express a lack of interest or even contempt for other phases of their own subject, to say nothing of the related fields of knowledge. I believe that the graduate schools should place more emphasis on thoroughness

and breadth of training for the majority of their graduate students who are planning to teach, rather than such great emphasis on a detailed mastery of a highly specialized field.

In scanning the personnel reports of college professors who have won their doctorates, it is very impressive to note the large number who have published nothing since they published their thesis for the doctorate. It would seem that the graduate schools might do well to discriminate as early as possible between those students who have marked ability for research work and those who have not. Those who do not show large promise in research might be directed to study more broadly and gain a wide comprehensive knowledge of their fields. Such students might well receive a different degree, and such men would find a ready welcome on the staffs of American colleges.

In the third place, the graduate schools are not contributing as much as they easily could contribute toward preparing their students for teachers. While it is interesting to note a distinct change for the better in the attitude of young men coming from the graduate schools toward teaching, I still feel, however, that not a few are coming somewhat imbued with the idea that students are a nuisance and interfere with work, that teaching methods are unworthy of serious thought, that anybody who knows can teach, and a good many other ideas which are only half-truths or are wrong. The great majority of men and women who enter the graduate schools leave them to enter colleges to earn a living as teachers, and it seems to me that the colleges might well insist that the graduate schools concern themselves, at least somewhat, with instilling into the minds of students the importance of careful methods of teaching, of imparting knowledge in an enthusiastic and interesting way, and with the tremendous importance of human interest in their students. None of us as college presidents, or deans, or professors desire to add to our staffs men who are not interested in students as human beings, who do not wish to concern themselves with students as people. It seems to me that these matters could be given some added significance in the graduate schools.

In the fourth place, so far as I know, only one graduate school in the country, Princeton, is making an earnest, serious effort to give to their men something of the social training and the broad sympathy and interest in all departments of learning which a gentleman and scholar should have. I believe those of you who have visited the Princeton graduate school and are familiar with the life there, and those who have employed graduates of this school have felt that Princeton has made a real contribution to the field of graduate teaching through the life of the graduate college at Princeton.

Many men who are today entering the field of graduate study with the intention of becoming teachers have had rather meager opportunities at home to absorb the finest ideas of social customs of the society of today. Many others have not concerned themselves with any field beyond the one of their specialty. We certainly need in the colleges men who, as cultivated gentlemen, are personal examples to the crude youths who enter our doors. We need men who through their broad sympathy and interest in all fields of scholarship can fire the enthusiasm for learning in the hearts of young men. The graduate schools would do well to concern themselves with an effort to make what contributions are possible to the training of their students along these lines. It seems to me that one of the next big steps before the graduate schools of our country is to provide dormitories for single graduate students and simple apartments for the married students so that they can live in the atmosphere of the university and gain from association with their fellow graduate students what means so much to the undergraduates in the colleges through common fellowship.

WM. MCPHERSON

ABSTRACTS

Photosynthesis of Naturally Occurring Compounds. E. C. C. BALY. *Rice Inst. Pamphlet*, **12**, 65–104 (1925).—Reactions are divided into two classes depending upon the amount of the increment of energy necessary to activate the reactant molecules. A highly endothermic reaction, as the conversion of H_2CO_3 into HCHO, requires a large increment of energy. When a solution of H_2CO_3 is atomized in the neighborhood of a Hg lamp, the H_2CO_3 is activated, the reaction $H_2CO_3 \longrightarrow HCHO + O_2$ takes place. The resulting molecules are themselves activated and HCHO polymerizes to form hexoses. Activated HCHO reacts with NH_3 to give piperidine and coniine and with KNO_2 yields formhydroxamic acid. In the living plant the photochemical equilibrium $H_2CO_3 \longrightarrow HCHO + O_2$ is disturbed by the removal of oxygen from the system by union with the plant pigments.

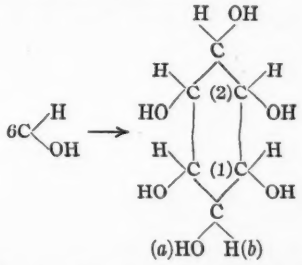
The plant mechanism is believed to be a four component system involving three separate reactions:

(1) $\underset{\text{(Chlorophyll A)}}{C_{55}H_{72}O_5N_4Mg.H_2CO_3} \longrightarrow \underset{\text{(Chlorophyll B)}}{C_{55}H_{70}O_6N_4Mg.H_2O} + HCHO$

(2) $C_{55}H_{70}O_6N_4Mg.H_2O + \underset{\text{(Carotin)}}{C_{40}H_{56}} \longrightarrow \underset{\text{(Xanthophyll)}}{C_{40}H_{56}O_2} + \underset{\text{(Chlorophyll A)}}{C_{55}H_{72}O_5N_4Mg}$

(3) $C_{40}H_{56}O_2 \longrightarrow C_{40}H_{56} + O_2$

The formation and polymerization of the activated HCHO is strongly influenced by the temperature and hydrogen-ion concentration. The yield of reducing compounds is decreased in either acid or alkaline solutions. The abnormal reactivity of HCHO is expressed by the Nef formula $C\langle^{H}_{OH}$. This activated compound will strive to obtain the most stable condition with quadrivalent C.



This molecule may undergo four changes: 1. The symmetrical loss of three molecules of water to give phloroglucinol. 2. The migration of H atom (*a*) to C atom (1) with the rupturing of the ring and formation of glucose. 3. The migration of H atom (*a*) to C atom (1) and H atom (*b*) to C atom (2) to give fructose. 4. The loss of energy to form inosite.

The nitrogen compounds in plants are the results of photosynthesis. Activated HCHO unites with the nitrites and ammonia in the plant foods. T. G. T.

The Mineral Elements in Animal Nutrition. J. B. ORR. *Nature*, **116**, 500–3 (1925).—Orr points out that since the time of Lavoisier research in nutrition has been directed chiefly to the chemistry and metabolism of organic compounds, but during the past half century an increasing number of workers have become interested in the role played by inorganic salts. In living matter the mineral elements are present, partly in chemical combination with organic compounds and partly free or potentially free either in solution as salts or ions in the water of the protoplasm, or in a temporary loose union with colloidal material. All forms of life depend ultimately upon the transformation of the energy of sunlight into chemical energy. The power of carrying out this fundamental process is possessed by inorganic salts in colloidal solution. Definite degrees of concentration of various ions in the cell fluids are necessary for the maintenance of normal protoplasmic activity. The ions also affect the permeability of membranes and the tensions at interfaces. Primary anemia, simple goiter, and rickets may be produced by deficiency of iron, iodine, and either calcium or phosphorous, re-

spectively. Diseases may also be produced by an excess of a mineral element. There are also cases of malnutrition due to lack of balance of the mineral elements in the diet where the signs are much less obvious as retarded growth or low vitality of the young at birth. Experimental results are given and a warning is sounded to those interested in animal husbandry. The subject is most complicated and much academic and practical work is still to be done. H. K. M.

The Discipline of Chemistry. C. H. DESCH. *Nature*, **116**, 504–5 (1925).—Two tendencies are clearly visible in the chemistry of today and are profoundly affecting our method of study and instruction and also the direction of research. On the one hand chemistry is being split up into a number of distinct specialisms and workers are tempted or even compelled to confine themselves to a narrow field; on the other, the boundaries between the several sciences are becoming less definite through the development of border sciences which themselves become new specialisms. Whether we look at the serious publications dealing expressly with the progress of science or at the mass of popular articles in newspapers and periodicals we see that the center of interest lies in the new discoveries and hypotheses of physics. It appears to be thought that chemistry is fated to become a branch of physics and thus to lose its own peculiar discipline, leaving its long-established methods to chemists engaged in operations of a routine character, while new knowledge is being acquired by the application of physical methods of experiment and interpreted by the methods of mathematical physics.

Chemistry is an experimental science which progresses by the application of a definite discipline, obtaining conclusions by induction from the observed facts and making use of deduction from a small number of well-tried hypotheses where required. Desch discusses the chemical hypotheses which have survived to the present day and while recognizing the value of the new ideas, ventures to utter a word of warning. The modern student tends to specialize in his scientific studies at a very early stage, and, if introduced in detail to the new conceptions while still engaged in learning the elementary facts of chemistry is likely to suppose that the facts depend on the theory instead of the opposite being true. The facts should be known to the student before he applies to them this interpretation, which may prove so fascinating as to distract his attention from the experimental basis of the science. H. K. M.

Discharge of Electricity through Vacuum Tubes. R. WHIDDINGTON. *Nature*, **116**, 506–9 (1925).—The discharge is considered under three headings:

(1) The cathode region, comprising the softly luminous cathode glow, the Crookes' dark space, and the negative glow;

(2) The anode region, consisting of a very thin layer of light on the anode surface;

(3) The central region, including the positive column continuously glowing, sometimes striated, separated from the cathode region by the Faraday dark space and extending right up to the anode.

Speaking generally the current passing through the tube will be carried almost entirely by electrons and positive ions, negative ions being comparatively unimportant. Owing to the difference in nature of these two types of carrier, however, and their interdependence, important space charge effects within the tube and area charge effects over the walls are set up, which play an important part in determining the electric forces and thus the nature of the discharge. H. K. M.

The Making of Soap. LENA C. AHLERS. *Sch. News*, **39**, 21–2 (1925).—A chemical story suitable for intermediate grades. R. M. P.

June Visits a Glue Factory. LENA C. AHLERS. *Sch. News*, **39**, 27–8 (1925).—Chemical facts embodied in a story for young readers. R. M. P.

Two Engineers and Their Power Plants. R. C. MOORE. *Ill. Teacher*, **14**, 37 (1925).—A comparison of the power generated and used in a large power plant with that in an educational institution which produces ideas, ideals, mind, character, culture, happiness. R. M. P.

Pure Research and Practical Research. W. W. CHARTERS. *J. Educ. Res.*, **12**, 95 (1925).—The author presents an interesting comparison of the work done by investigators in pure and applied fields. He states that the financial investment in pure research is an insurance premium paid by society as a protection against stagnation. Many principles discovered in the realm of pure research have later become of great value to society. Thus Benjamin Franklin's kite and key, once objects of derision, have become a corner-stone of recent civilization. In pure research there are two steps. First, a problem may be selected from any source, and second, a scholarly solution must be found.

The investigator in the applied field finds the selection of his problem narrowed by the conditions under which he is employed. Five steps are outlined in practical research:

First, a study of the organization is made to see wherein it fails to function; second, a problem is selected for intensive study; third, original work leads to a solution; fourth, the new plan is installed and adjusted to conditions; fifth, steps are taken to make the new installation a permanent part of the system. R. M. P.

Making the Laboratory the Basis of High-School Science. H. H. RADCLIFFE. *Sch. Sci. Math.*, **25,** 749–52 (1925).—The writer relates his experience in teaching several sciences which serves as a basis for the following conclusion: "Chemistry and physics are nature studies. As I recall and continue to study the minds of my pupils, I have been led to believe that a first hand study of the objects of Nature, or of objects which illustrate the laws of Nature, followed, not preceded, by a discussion of these laws will be the most thought-provoking method of procedure in high-school science. It seems to me, above all else we want our pupils to THINK." H. R. SMITH

The Character of Laboratory Work for Students of Elementary Chemistry. W. G. BOWERS. *Sch. Sci. Math.*, **25,** 711–20 (1925).—Two conditions must be considered: the ability and life work of the pupil. The author thinks the practical and theoretical should be mixed. He discusses the views of four former writers of the same journal extending back to 1905. "One must conclude that the teacher who advocates the practical at the expense of the theoretical or fundamental is doing one or the other of the following unprofessional things: he is confessing that he thinks the foundations of chemistry are so difficult that a sufficient number of workers in the field for the world's welfare will be unable to pursue the subject, or he is discrediting the intelligence of the young people by claiming that they cannot be interested unless they are started out in the 'spotlight phase' or the 'immediate results branch' of the subject, or he is contending that a smattering of methods of following recipes is the better way to develop general culture in a young person, or he is trying to popularize his subject and induce large numbers into his classes for the sake of his own glory." H. R. SMITH

The Training of Teachers. F. B. MALIM. *J. Educ. and Sch. World*, **57,** 680–2 (1925).—Malim admits that few people would be found to deny the general proposition that a man will do his job better for being taught how to do it. He then gives two reasons in the choosing of teachers why it is not the habit to require any external training at all. In all schools the personality of the teacher is more valuable than his scholarship, his method, or his equipment. Why not select the man with the personality sought but insist on his being trained? Training may either follow the degree course or be pursued at the same time with it. If a man is doing two things at the same time, there is real danger that one of these will be scamped. If on the other hand some insisted on a period of post-graduate training, they would find that the best candidates were being absorbed by schools whose heads were less exacting. If all heads so insisted, the number of suitable candidates would be much reduced; the present tendency for the ablest men to seek administrative or commercial posts would be accentuated.

But there is a further reason. Sometimes the trained teacher teaches too much. The test of an hour profitably spent in a secondary-school class-room is not how much time has the teacher spent in preparing the lesson or how skilful has been his presentation of his subject but, how much intellectual effort has been made by every boy in the class. The solid work of learning, each must do for himself.

It is maintained that engineers are best trained in the so-called "sandwich" system, by a judicious blending of theory and practice. In the same way M. believes that a man will approach the theories of writers on education with greater appreciation and in a more critical spirit, if he is already engaged in endeavoring to hold the attention and stimulate the diligence of a form for whose progress he is responsible. His problems are real problems, and he will really want to find their solution. H. K. M.

The Future Science of the Schools. W. M. HELLER. *J. Educ. and Sch. World*, **57,** 686–8 (1925).—A further discussion of the subject brought up by Professor Armstrong (for abstract, see THIS JOURNAL, **2,** 940 (1925)). Pupils come to us with a mass of unorganized natural knowledge learned in the best school of all, experience gained by voluntary observation and attention. It is the function of the teacher: (*a*) to utilize this knowledge by a constant appeal to the pupil's experience, (*b*) to correct it and systematize it, (*c*) to relate it to new knowledge gained as a result of deliberate and purposeful observation and experiment. The failure to base our teaching upon this natural foundation of knowledge has led to a wrong approach of the subject and is responsible for the unsatisfactory position it still holds in the public estimation.

The full cultural value of science is attained only when instruction is truly experimental, that is to say, when it is undertaken with the deliberate purpose of solving a difficulty already fully discussed, and which pupils appreciate as clearly as the teacher. School laboratory work is of two kinds: 1. *Experiments*, undertaken with a definite

purpose after careful discussion, carried out to the maximum degree of accuracy that the nature of the apparatus and the skill of the student will permit and the results utilized for the explanation of common experience and the suggestion of new problems. 2. *Exercises*, practical work set to gain dexterity and accuracy of manipulation and to give reality to theoretical instruction. Both types of practical work provide essential training, but the latter type is often far too dominant. Pupils are kept too much in the dark as to the purpose of the work they have in hand.

Too little importance is attached to time-factor in practical and manual instruction. Speed is the essence of skill and accuracy because it implies concentration. The pernicious system of working in groups of two or more pupils is responsible for great waste of time and defeats many of the purposes which laboratory work is intended to achieve.

H. K. M.

The Transmutation of Uranium into Uranium-X. A. GASCHLER. *Nature*, **116**, 396–7 (1925).—G. examines U and Th and their salts in the electric arc and in the glow discharge in evacuated tubes. In no case could there be observed an alteration in the radio-activity or in the chemical activity. A perceptible transmutation effect was, however, found when strong rushes of momentary high-tension currents were sent through a narrow fused quartz tube provided with W electrodes and containing Hg covered with a thin layer of Uranium oxide which had been fused from U-X. Under the influence of repeated electric discharges increasing radio-activity, measured according to β- and γ-ray method, showed itself. Contents of the tube were dissolved in HNO_3 and the artificially produced radio-active material separated by methods by which U-X can be separated from U. The half-period time was that of U-X. β- and γ-rays activity was 1.4 to 20 times the radio-activity of an equally large amount of Uranium oxide in equilibrium with its decay products and increased proportionally to the energy applied and to the time.

H. K. M.

The Isotopic Composition and the Atomic Weight of Chlorine in Meteorites. W. D. HARKINS AND S. B. STONE. *Nature*, **116**, 426 (1925).—The atomic weight of chlorine indicates that in earth this element consists of 76.6_5 per cent of chlorine of isotopic number 1 (atomic weight = 35) and of 23.3_5 per cent of isotopic number 3 (atomic weight = 37). Within the limits of error the atomic weight of meteoritic chlorine is found to be the same as that of this element from wernerite, from apatite, and from purified commercial hydrochloric acid.

H. K. M.

Cultural Aspects in Geology. W. A. PARKS. *Nature*, **116**, 432–5 (1925).—From the presidential address delivered before Section C of the British Association. P. attempts to introduce no new facts but lays emphasis on a selected few of the many great lessons of geology.

H. K. M.

The Russian Academy of Sciences. EDITORIAL. *Nature*, **116**, 448–9 (1925).—A meeting was held at the London Central Y. M. C. A., September 10, in connection with the bicentenary of the R. A. S., the celebration of which has just been concluded at Leningrad and Moscow. An interesting account of the history of the society and of the work now being carried on.

H. K. M.

The Ups and Downs of Nitrogen. I. GRIFFITH. *Am. J. Pharm.*, **97**, 229 (1925).—This paper is especially interesting from the point of view of teachers of chemistry. It contains a long and detailed description of the experiences of a nitrogen atom taken directly from the diary of a nitrogen atom. The writer reviews in detail the fixation of nitrogen and in his characteristic humorous manner relates the interesting experience that a nitrogen atom undergoes in being fixed from the atmosphere and transformed into fertilizer appearing in the form of a plant, being taken into the alimentary tract of a human being, being released again at the death of the individual after cremation.

An interesting sidelight on the study of nitrogen for the freshman class. KRANTZ

Chemistry in and about the Home. F. P. STROUP. *Am. J. Pharm.*, **97**, 213 (1925).—In this article the writer reviews the chemistry of every manipulation in the household, from the washing of the face in the morning to the cleansing of the supper dishes at night. The paper is especially interesting for the chemistry students who are pursuing courses in home economics.

KRANTZ

Pharmacy Teacher Training. F. K. WULLING. *J. Am. Pharm. Assoc.*, **14**, 797 (1925).—Again the scarcity of pharmacy teachers is emphasized by the writer. It is advocated that the young man temperamentally fitted for teaching pharmacy should be required to pursue courses in pedagogy along with technical work for his Master's or Doctor's degree.

KRANTZ

Education for Profit. W. F. RUDD. *J. Am. Pharm. Assoc.*, **14**, 795 (1925).—A statistical study of the earning capacities of professionally trained and non-professionally trained men is reviewed. Evidence is brought to bear upon the fact that profes-

sional training is valuable from the standpoint of monetary return. The writer takes into consideration the comparatively small salaries paid to teachers in professional schools, but further emphasizes that their reward of service rendered cannot well be measured by dollars and cents. KRANTZ

A New Method of Zinc Coating Wire. J. L. SCHUELER. *Metal Ind.*, **23,** 364–6 (1925).—A much thicker coating of zinc may be applied to a wire if the coated wire is passed directly from the molten zinc (which need not be high grade) to annealing furnaces. The heat treatment not only smooths the coating, causing it to form evenly, but makes the coating malleable and flexible. A heavily galvanized wire may be bent around its own diameter without injury to the coating. Galvanized barb-wire prepared by this method had 2.62 g. of zinc per square decimeter of wire surface compared with 1.04 g. on wires manufactured by firms using the old galvanizing process.

G. B. HEISIG

Value of the Photograph in Judging Human Character. D. G. PATTERSON. *J. Minn. Educ. Assoc.*, **5,** 18–9 (1925).—The ability of different persons to judge traits of character from a photograph has been tested by a number of investigators. Hollingsworth submitted photographs of 25 strangers to a large number of judges. Their decisions showed good agreement among themselves concerning intelligence, perseverance, and kindliness, but less agreement concerning traits of humor or deceitfulness. There is only a very slight relationship between estimates made by any judge and the true facts about the person considered.

Pinter submitted photographs of twelve children selected at random from those examined at a psychological clinic, to various groups of judges, psychologists, physicians, teachers, students, and clerical workers, with the request that the intelligence be rated from the photograph. The conclusions of the judges were checked against results obtained from standard objective intelligence tests. The results showed that the estimates of any single judge were entirely unreliable. The best single judge proved to be a stenographer and the poorest an experienced clinical psychologist.

Similar experiments by Pope, using pictures of women graduates uniformly dressed in cap and gown, by Anderson using photographs of executives and employees in a Pittsburgh department store, by Laird and Remmers using pictures of college students, and by Omwake using numbers of pictures representing ages from 6 to 60, show that the photograph is practically useless in estimating a person's intelligence. Patterson concludes, therefore, "that the photograph yields no useful information concerning the applicant and benefits chiefly the photographer." G. B. HEISIG

Chemical Apprentices. G. A. HERRMANN. *Chem. Bull.*, **12,** 223 (1925).—Trades and crafts are experiencing a shortage of apprentices. The chemical profession is also among those affected. Most of those who enter chemical work are trained by educational institutions. Many students do not feel inclined to follow chemistry because they lack self confidence and this is not because of a proper knowledge of the theory but rather due to the fact that the theoretical treatment has been overemphasized. There has not been sufficient emphasis upon the adaptation of "the information to practical problems."

In contrast with the student type of worker is the mechanical routine worker who analyzes "cook-book fashion" with no knowledge or care as to the why and wherefore of the operations.

Many students work to partly take care of college expenses. Why not arrange that students interested in chemistry find such employment in chemical jobs instead of in restaurants, hustling trunks, and such which carry no valuable training for them? Such an arrangement might also, in the end, place many more competent people in the chemical work as a profession, not by accident but by deliberate choice.

B. CLIFFORD HENDRICKS

The Lecture Method. H. R. SMITH. *Chem. Bull.*, **12,** 224 (1925).—Is the lecture method an inefficient throwing out of information with the probability that a large per cent of it will go wide of the mark? To answer this it is necessary to know what both the educational and experiential background of the listener is. Of course, for this background to be effective the student must be mentally active.

Inquiry of students who have sat under lecture instruction reveals wasteful expenditure of effort upon copious note-taking. Hastily written notes are not only lacking in dependableness, but in the act of getting them the student often loses the major value of the lecture, that is; subject perspective and inspiration. One argument for the method, which is quite sure to receive attention, is the greater economy of lecture instruction over against class-room teaching with smaller groups.

B. CLIFFORD HENDRICKS

Nature and Ultranature. J. E. TURNER. *Monist*, **35**, 555–66 (1925).—Evolution of life manifests itself in the mastery of the environment as the living organism is responsive to it. "Evolution is essentially immanent activity" and must be explained as resulting from internal factors rather than external. Conscious experience is dynamic and never merely passive. The influence of reason is internal and individual, that of instinct is external and general. Reasoned knowledge is the manifestation of the mind's conquest of environment. The character of Nature is ever changing; "its earlier simplicity has vanished before the modern revelation of its unsuspected intricacy. Nature implies something more and deeper than itself and this is termed ultranature, which is in reality continuous with Nature." T. G. T.

H. G. Wells on Education. ADA E. DAVIS. *Education*, **46**, 72–95 (1925).—An interesting outline and criticism of Wells' ideas on education. T. G. T.

A Rating Scale for Practical Teachers. J. S. KINDER. *Education*, **46**, 108–14 (1925). T. G. T.

Speed of Light Known within Twenty-Five Miles per Second.—One man in the world, Prof. Albert A. Michelson of the University of Chicago, now knows within twenty-five miles per second just what the speed of light is, and he promises that by the end of next summer he will have the figure correct within five miles, or perhaps even one mile, per second. Light travels with an approximate speed of 186,300 miles per second, so that the present figure is correct within approximately one ten-thousandth of one per cent of error, and the promised determination within five miles per second of the exact speed will be correct within three one-hundred-thousandths of one per cent.

Prof. Michelson has been refining his measurements of the velocity of light through further experiments at the Mt. Wilson observatory in California.

The light measurements were made between Mt. Wilson and Mt. San Antonio, a distance of about twenty-two miles. Prof. Michelson projected a powerful light through a narrow slit onto a mirror which was spinning at the rate of about 30,000 revolutions a minute, which in turn projected it on a reflecting apparatus at the far station. The reflector returned the light to the original source. With an accurate knowledge of the rate at which the mirror is revolving and the distance between the two stations, Dr. Michelson found it easy to calculate the velocity of a ray of light.

With the perfection and refinement of the mechanical devices the noted physicist plans to repeat the experiments in the summer of 1926. He said that he would try to measure the velocity between two stations about 100 miles apart. The present revolving mirror is to be replaced with one which is much larger and capable of projecting three times as much light over a given distance.

Prof. Michelson points out that the velocity of light is increasing proportionally with the decrease in the velocity of the earth. With this decrease in the earth's velocity our unit of time measurement is constantly being lengthened, and as the relative length of our second becomes longer so will the velocity of light become faster, he said.

There are practical uses for an accurate figure for the velocity of light. Knowing the velocity, it is perfectly possible to reverse the experiments and measure distances between points with an error of less than one part in a million. This is an accuracy which no engineering instrument can ever hope to attain.

The experiments of the summer of 1924 gave 186,300 miles per second as the nearest approach to the actual figure. This figure, Dr. Michelson stated in announcing it, is accurate within twenty miles. He asked to be excused from giving the exact figures obtained this summer, stating that he preferred to wait until his next season's work shall have given him the nearest approach to absolute accuracy obtainable by present methods.—*Science Service*

Local Activities and Opportunities

N. E. A. C. T. The 97th meeting of the New England Association of Chemistry Teachers and the 10th meeting of the Western Division was held December 5th at the Central High School, Bridgeport, Conn. It was a joint meeting with the Chemistry Teachers' Club of New York and the New Haven-Bridgeport Section of the A. C. S.

The morning session started with two trips, one to the Bridgeport Brass Company and one to the Remington Arms Co. At 11:30 Professor Stuart R. Brinkley, Yale University, discussed the problems of "How to Teach the Electronic Theory to Beginners of Chemistry." At noon, luncheon was served at the High School by the domestic science department.

The afternoon session was in charge of the Chemistry Teachers' Club of New York. The address of welcome was given by Mr. Carrol R. Reed, Superintendent of Schools in Bridgeport. Dr. James Kendall, Columbia University, discussed "The Rare Earths with Specimens and Demonstrations."

Dr. S. R. Powers, Teachers' College, Columbia University, presented "A Summary of Two Recent Investigations Related to the Overlapping of High School and College Chemistry." This discussion was followed by a paper by Mr. Henry S. Johnson, New Haven High School, and Captain of the Reserve Corps, Chemical Warfare Service, on the "Relation of Chemical Warfare to National Defense."

Business meetings of both the organizations were held and the laboratories were inspected. Supper was served in the High School for the members of the A. C. S. and guests who remained for the A. C. S. meeting in the evening. At that meeting, Dr. Neil E. Gordon, Editor of the JOURNAL OF CHEMICAL EDUCATION, talked on "The Goal of Chemical Education."

W. S. A. C. T. The Washington State Association of Chemistry Teachers held its first annual meeting in connection with the convention of the Washington Educational Association at Tacoma, October 29th. The meeting was called to order by the president, Prof. H. C. Philippi of Washington State Normal School. The following program was given:

"Chemistry as a Catalyst," Dr. H. K. Benson, University of Washington.

"Chemistry, the Handmaid of Industry," E. D. Clark, Director of the National Canneries' Association, Northwest Laboratories.

"The Construction and Use of Standardized Objective Tests in High-School Chemistry Teaching," F. A. Rantz, Roosevelt High School, Seattle, Washington.

"The Relation between High-School and College Chemistry Curricula and Methods of Instruction," H. E. Pratt, Eatonville High School.

"The Scientific Testing of Results in College Chemistry Teaching," Dr. S. G. Powell, University of Washington.

Kansas City Section of the A. C. S. The 25th anniversary of the Kansas City Section of the American Chemical Society was celebrated, November 6th, at the University Club, Kansas City, Missouri. All of the original Charter members were invited to attend the meeting. The following program was given:

"Chemistry 25 Years Ago Today," Dr. Edward Bartow, Iowa State University.

"Chemistry 50 Years Ago Today," Dr. E. H. S. Bailey, Kansas University.

"Chemistry 25 Years *from* Today," Dr. H. P. Cady, Kansas University.

University of Nebraska. The district meetings, November 4th, 5th, 6th, and 7th,

of the Nebraska State Teachers' Association brought groups of teachers together in six districts. Topics of interest to Chemistry teachers were as follows: "The Chemistry Laboratory," Wesley R. Bratt, Hastings; An Address by H. O. Sutton of Kearney State Teachers' College; "Connecting High-School Chemistry with the Everyday Life of the Pupil," by R. S. Mickle of Fairbury; and "Chemistry Teaching in Nebraska," by W. F. Hoyt, Peru State Teachers' College.

Preliminary and survey examinations were held the last weeks of October at the University of Nebraska for chemistry students working toward graduate degrees. The list included eleven candidates for the master's degree and six for the doctorate.

Purdue University. Dr. Mahin, who has been acting head of the department of chemistry at Purdue University since the death of Dr. Evans, has resigned from this position and will be located at Notre Dame University. Dr. A. R. Middleton is now acting head of the department, Dr. R. E. Nelson is in charge of the organic chemistry, Dr. M. G. Mellon of Quantitative Analysis and C. B. Pollard is giving lectures to the sophomore engineers. Dr. F. O. Anderegg is dividing his time between the School of Chemical Engineering and the Engineering Experiment Station.

The new assistants at Purdue this year include the following: Lee Huber, Wabash; F. N. Alquist, Clark University; Miss Marjori Clark, Purdue; W. E. Fish, Shurtleff College; J. R. Matchett, Earlham College; F. R. Swim, Kansas Agricultural College; J. R. Tindall, Purdue.

Connecticut College of Pharmacy. On Oct. 20, 1925, the opening exercises of the new Connecticut College of Pharmacy were held in New Haven. The old Yale Medical School building has been remodeled for the use of the new institution. The Connecticut Pharmaceutical Association has provided funds for establishing the school and is acting as its sponsor. Prof. Curt Wimmer of the Columbia College of Pharmacy has had charge of organizing the new college. Nearly ninety students are registered in the first freshman class. Dr. Gustavus Eliot is to be Dean of the College and Henry Stoddard Johnson, formerly professor of chemistry at the University of Porto Rico, is to have charge of the chemistry department. The work of this college, the newest of Connecticut's educational institutions, is destined to play an important part in the practice of Pharmacy in that state.

The American Conference of Pharmaceutical Research held its annual meeting at Des Moines, Iowa, during the last week of August. At this meeting reports were received from all of the affiliated associations including the American Chemical Society. The census of pharmaceutical research, which has appeared in the official publication of the American Pharmaceutical Association was discussed and further methods of keeping this up-to-date were decided upon. At this meeting it was also advocated that the Conference, through its parent organization, the American Pharmaceutical Association, publish a popular book on the service of pharmacy to humanity, in order to familiarize the laity with the scope and spirit of the profession of pharmacy.

The annual research grant of $450.00 was awarded at this meeting.

The American Conference of Pharmaceutical Faculties held its annual meeting in Des Moines the last week of August, 1925. During a revision of the Constitution and By-Laws it was decided to change the name of the Conference to the American Association of Pharmacy Colleges. The contents of the three-year curriculum were fully discussed and in most of the pharmacy colleges arts and science chemistry is being taught for the first two years. In the third year physical and pharmaceutical chemistry is given and in the fourth year physiological chemistry and more highly specialized pharmaceutical chemistry are the courses advocated.

K. A. C. T. The Kentucky Association of Chemistry Teachers held their fall

meeting at the University of Kentucky, Lexington, Ky., November 28th. The following program was given:

MORNING SESSION: 11 A.M.

"Welcome"—President McVey.
"Address"—Dr. Norris, President of the A. C. S.

AFTERNOON SESSION: 2 P.M.

"Chemistry Essay Contest"—Dr. F. E. Tuttle, University of Kentucky.
"Calculations in First Year Chemistry"—Dr. A. W. Homberger, University of Louisville.
"Discussion of Minimum Essentials"—Mr. R. L. Brown, Du Pont Manual Training High School, Miss Myra Bedinger, Kentucky Home School, and Mr. J. C. Branham, Massie School.
"Lecture-Table Demonstrations"—Dr. R. N. Maxson, University of Kentucky.

University of Louisville. Forty members of the University of Louisville Chemistry Club attended the meeting which was held November 5th. The program consisted of three talks, "Petroleum" by Frank Shipman; "The Relation of Research Work to Modern Chemistry," by Malcolm Charlton; and "The Alchemy Period in the History of Chemistry," by Ruby Mason.

Dr. Homberger, head of the department of chemistry, will offer a prize for the best talk on a chemical subject given during the year at a regular meeting of the Chemistry Club.

Cornell Section, A. C. S. A meeting of the Cornell Section of the A. C. S. was held November 11th at Cornell University. The two following papers were given: "Membranes," by Charles Gurchot and "Adsorption Spectra," by C. V. Shapiro.

On November 17th, a talk on "Rambling Vacation Observations, London and Vienna," was given by Professor L. M. Dennis, in Baker Laboratory at Cornell University. The talk was illustrated by lantern slides. The general public was invited.

W. Va. C. T. A. A meeting of the West Virginia Chemistry Teachers' Association was held November 14th at West Virginia University. Some items of business including the election of officers were considered. There were also a number of short talks and informal discussions.

University of Florida. To acquaint citizens of the state with the importance of chemistry in the development of its natural resources, a series of nine articles have been written by members of the chemistry staff and the faculty of the College of Pharmacy and published in several of the leading daily papers of the state.

Special series number 8, "Some Essentials of Photography," published by the General Extension Division of the University, is just off the press. It is an interesting monograph written by Prof. Fred H. Heath, of the chemistry staff.

Dr. James F. Norris, President of the A. C. S., addressed the Florida Section at a meeting held in Gainesville on December 5th. His subject was "Recent Advances in Organic Chemistry." Preceding his address, a banquet was held in his honor, at which members of the Section and many invited guests were present.

Two books written by members of the chemistry staff are proving very satisfactory in the course in General Chemistry. One is entitled "Laboratory Manual of General Chemistry, with Notes on Qualitative Analysis." The other "General Chemistry Problem and Question Book" has proven most convenient for the assignment of outside work. Both have been published in mimeograph form by the joint authors, Professors Fred H. Heath and Walter H. Beisler.

Mr. Donald Hubbard, M.S., U. of Florida, 1924, is an assistant chemist at the U. S. Bureau of Standards, where he is engaged in research on photographic emulsions.

Mr. Fred Weedon, M.S., U. of Florida, 1923, is now at Emory University, Atlanta, Ga., engaged in research work in physiological chemistry.

Assoc. of Colleges and Secondary Schools. The fifth annual meeting of the Science Section of the Association of Colleges and Secondary Schools of the Middle States and Maryland was held November 28th, at Columbia University, New York City. The following program was given:

"Euthentics: A New College Department," Dr. Annie L. Macleod, Vassar College, Poughkeepsie, N. Y.

"Which Should Be Stressed in Teaching Chemistry—Text, Lecture, or Laboratory Work?" W. J. Hancock, Erasmus Hall High School, Brooklyn, N. Y.

"Science and the Dalton Plan at the South Philadelphia High School for Girls," M. Louise Nichols, South Philadelphia High School, Philadelphia, Pa.

"The Examination Problem," W. J. A. Bliss, Johns Hopkins University, Baltimore, Md.

"How to Teach Evolution in the Schools," Dr. Henry Fairfield Osborn, American Museum of Natural History, New York, N. Y.

After this program a business meeting was held, after which the Council and newly appointed committees met to discuss plans for the coming year.

Haverford. Dr. Harlan S. Miner of the Welsbach Company addressed the chemistry students at Haverford College on Friday, November 19th, on "The Rare Earth Elements."

University of Michigan. Every other Tuesday evening at 9:00 P.M. a "Michigan Night" program is being broadcast from University Hall through WJR. This program consists of a variety of musical numbers by members of the School of Music, interspersed with four-minute talks by faculty members. The first hour, October 27th, was used in part by President Little to present some of his ideas. He was followed by Dr. H. A. Haynes, director of the University Hospital; W. B. Shaw, general secretary of the Alumni Association; J. S. Reeves, of the political science department, and Fielding H. Yost, director of intercollegiate athletics.

The third program, on November 24th, in addition to the musical numbers included a talk by Dean Cabot of the Medical School on "The Making of Doctors." F. N. Scott of the rhetoric department discussed "The Standard of American Speech;" W. D. Henderson, director of the Extension Division explained "The Michigan Coöperative Plan for Community Center Service" and N. H. Williams of the physics department talked about "The Outposts of Science."

It is expected that these programs will be continued throughout the winter and will be so organized as to furnish entertainment and acquaint the radio public with the major activities of the University. Formal instruction in any field of higher education is not contemplated.

During the past month the chemistry department has been fortunate in having two well-known research men discuss their work. On November 12th, Roger Adams, professor of organic chemistry at the University of Illinois, spoke on "The Effect of Poisons and Promoters in Platinum Black Catalysis," and on November 18th, J. F. Norris, president of the American Chemical Society, presented some of his results on "The Quantitative Study of Chemical Reactivity."

The three days, November 19th to 21st, were given over by the Medical School to dedicating the new hospital. Programs of general interest, clinics, and lectures by specialists occupied the time. Many nationally known physicians and surgeons were present.

Chicago Association of Chemistry Teachers. On October 18th, Dr. W. Lee Lewis of the American Institute of Meat Packers addressed the Chemical Education group on the subject, "The Chemist in the Packing House Industry." After sundry references to the applications of chemistry to the subject the opportunity of a teacher to undertake the solution of community problems of chemical

phase was much enlarged upon and emphasized. Coöperation with civic authorities is a splendid example to young folk in the training for good citizenship and there are many problems requiring attention in every community.

Iowa Assoc. of Science Teachers. The chemistry-physics section of the Iowa Association of Science Teachers met at West High School, Des Moines, Iowa, on November 6th. The attendance was unusually large. An encouraging feature was the number of college men who were present. In the absence of Dr. F. E. Brown, who was unable to be present on account of illness, Professor W. F. Coover was chosen chairman.

The following program was given:

"Waves in the Ether," Prof. W. N. Kadesh, Iowa State Teachers' College.

"High-School Preparation for College Physics," Prof. M. J. Plagge, Iowa State College, Ames.

"What Can the Colleges and Universities Do to Aid the Teachers of Chemistry in the High Schools?" F. E. Goodell, West High School, Des Moines.

"What Should Colleges and Universities Do with Pupils Who Present Credits in High-School Chemistry?" Prof. M. F. Lewis, Cornell College, Mt. Vernon.

The Washington Section A. C. S. held its 372nd meeting at the Cosmos Club, November 12th. At this meeting the annual election of officers took place. The program consisted of ten-minute talks by W. Blum, E. Wichers, M. S. Badollet, E. W. Schwartze, W. M. Clark, M. X. Sullivan, E. Elvove, E. D. Crittenden, and E. C. White.

Syracuse University. A "Chemistry Homecoming" was held at Syracuse University, December 18th. On that evening the Syracuse Section of the A. C. S., all students in chemistry, and their friends were guests of Alpha Chi Sigma and Eta Gamma, the chemical fraternity and sorority, respectively. A letter was sent out to all teachers in the vicinity of Syracuse inviting them to bring their students to the meeting. Arrangements were made to house all out-of-town visitors as guests of the Local Section.

A part of the evening was devoted to a lecture by some of W. R. Whitney's men from the General Electric Company on "Atomic Noises." This lecture was open to the public. After the lecture the students put on a one-act play which they had written themselves.

A new course leading to the B.S. in Chemistry has been instituted at Syracuse University. In addition to his straight chemistry courses a student may elect accounting, finance, commerce, psychology, business management, and advertising and selling. The new course might be called "Administrative Chemistry." It was voted to require a knowledge of glass blowing before any of the chemistry majors can be ranked as juniors. A regular course in glass blowing is given each year. Each student must pass a practical examination. A one-hour course in chemical literature is also required for chemistry majors.

New Mineral Deposits Found in Siberia.—Rich veins of radium, gold, and other rare metals have been discovered in the Ekimchansky region of the Amur province, Siberia. A telephone line has already been constructed, coöperatives organized, and general signs of life are present in this formerly desolate region.

New deposits of phosphates were recently found in fourteen different localities of the government of Voronesh. The total area of these localities covers about 140 square miles and the deposits are estimated at 125,000 tons.—*Science Service*

Recent Books

Effects of Ions in Colloidal Systems. Dr. LEONOR MICHAELIS. Williams & Wilkins Co., Baltimore, Md., 1925. 108 pp. 18.5 × 12.5 cm. $2.00.

This book is a short summary of a series of lectures that were delivered in several American Universities during the spring of 1924. In all there are eight short chapters in the 108 pages, dealing with such subjects as adsorption in general, electrokinetic phenomena, origin of the electrical double layer, anomalies of charcoal, coagulation, Donnan membrane equilibrium, and lyotropic influences.

The treatment is entirely qualitative throughout, and were it not for the peculiar style of expression it would make profitable reading for an hour or two. The following sentence, for example, is submitted as evidence of the preceding statement: "May I be allowed to recall the fact that we measure the absolute zero point of a mercury electrode by investigating the conditions for the maximum of surface tension of a mercury meniscus, and, after all we know about this problem, this determination of the absolute value of the potential of mercury from a surface phenomena may be applied for the potential of the mercury which forms one pole of a galvanic chain, too; provided the surface tension is measured against such solutions which contain no strongly adsorbable ions."

There are, however, numerous ideas in the work that make the book worthwhile for the special worker in this field. This is especially true of the comments on the Donnan equilibrium and is also well illustrated by the following pithy statement; "The Gibbs theory of adsorption which deals only with surface tension has proved itself as practically rather fruitless and sometimes misleading."

The most glaring error in the book is the repeated statement that charcoal is the only substance capable of adsorbing capillary active non-electrolytes from solution. This point is greatly stressed in the chapter on charcoal, and its refutation would decrease the importance of the conclusions as drawn.

Such an exposition as presented in this little book of Professor Michaelis is valuable in so far as it emphasizes the need of fundamental investigation of a serious and careful nature in this field. For it certainly may be said with great emphasis that the problems of ion adsorption are at present largely unsolved. Indeed the author himself sums up the situation most admirably as follows: "It seems that in order to arrive at a satisfactory solution of this problem one should start from quite new fundamental suppositions. In the meantime we have to put up with the qualitative considerations given above."

W. A. PATRICK

Distillation in Practice. C. ELLIOTT. D. Van Nostrand Co., N. Y., 1925. xi + 188 pp. 43 figures and 16 tables. 12 × 18.5 cm. $2.00 net.

This is a companion book to "Distillation Principles" by the same author and a knowledge of the principles of the vaporization of liquids is assumed. The chapters are: simple distillation, fractionation, discontinuous fractionation, continuous fractionation, fractional condensation, heat transfer, apparatus, ethyl alcohol, petroleum, and coal tar.

The author does not hestitate to use mathematics where it is needed and there are many such places. In the first part general formulae are developed which are later applied to specific cases. There are a considerable number of references to the literature of distillation. The treatment of each topic is logical and the explanations and illustrations are sufficient but there is no excess. The material is packed somewhat closely and requires attentive reading. However, one who is not willing to do that kind of reading had better avoid this subject.

The book is for the student who is looking forward to practical work and for the practical man who is still a student and is trying to improve his methods and apparatus. It does not contain ready-made formulae and designs for all occasions but rather aims to help the student to help himself by pointing out the fundamentals and indicating ways of applying them.

Considerable information is given about actual practice in distillation. The illustrations are all diagrams or sectional drawings. Such sketches show much more about design and operation than do pictures of plants.

A notable feature is that attention is constantly called to gaps in our knowledge and to the desirability of more exact information on this point or that. In each formula it is pointed out which factors or relations are satisfactorily known, which are approximations, and which are only guesses. The reader is shown just how far he can tread firmly and where he must take a broad jump; how far he can calculate and where he must guess and hope for the best. This fosters honesty and encourages research to obtain the missing data.

E. EMMET REID

The Foundations of Colloid Chemistry. A Selection of Early Papers Bearing on the Subject. Edited, on behalf of the Colloids Committee of the British Association, by EMIL HATSCHEK, F. Inst. P., Lecturer on Colloids at the Sir John Cass Technical Institute, London. First edition, Vol. I. The MacMillan Company, New York, 1925. xii + 161 pp. 23 × 14.5 cm. $6.00.

The present book represents the latest, but it may be hoped not the last, activity of the British Association Committee on Colloid Chemistry, which has already sponsored five valuable reports on the subject. It being decided to reprint some of the early literature on colloids, the scope was narrowed by eliminating papers by living authors. This has enabled certain relatively inaccessible literature on colloids to be republished and belated but desirable attention to be directed to the work of certain early pioneers.

The value of such editions as the present cannot be easily overrated. Many students are either unable to refer to original texts of pioneers' work or are not sufficiently attracted thereto. Yet the contact with such fundamental papers should not be missed. The pioneers did not describe their observations in a terminology already shopworn and over-familiar, but invented the terminology as they proceeded. Thus when they proposed new terms, as was done by Selmi and Graham, they stated exactly their significance and the reasons for adopting them. Again, they were not encumbered with pre-existing theories, but were meeting and creating new facts and a new technic with unprejudiced vision.

The papers which are reprinted in this edition cover a wide range, extending as they do over the physiological chemistry of fats and proteins, the preparation and properties of inorganic hydrosols, the properties of hydrogels in regard to water, and the general properties of colloidal systems. Some of these, such as the paper "On the Experimental Relations of Gold (and Other Metals) to Light," by Michael Faraday, the one by Van Bemmelen "On the Nature of Colloids and their Water Content," and that, "On the Properties of Silicic Acid and other Analogous Colloidal Substances," by Graham, are already classics of colloid chemistry. Others, notably Francesco Selmi's "Studies on the Demulsion of Silver Chloride" and the "Pseudo-Solutions of Prussian Blue," and Ascherson's "Physiological Utility of the Fats" are fundamental papers, which have been over-looked till recently and which equally deserve the title of classics. The object of the British Association Committee on Colloids in drawing attention to the work of these early pioneers should be greatly helped by this book, which will assist in broadening the historical foundations of the science. The editor in the preface rightly calls attention to the "strikingly modern views" of Ascherson on adsorption and membrane formation, which (p. 24) he regards as "a physical property, as a kind of capillary condensation which proceeds at the surface of heterogeneous liquids in contact." Thus early (1838–40) was the physical theory of adsorption outlined. Selmi's papers, in addition to the wealth of sharpsighted special observations on "pseudo-solutions," will interest students alike of chemistry and the history of ideas for their premonition of the division of colloids into suspensoids and emulsoids and for his searching sketch of the continuity of dispersion of matter from true solutions to coarse emulsions and suspensions. In this connection he says, "there is, however, a special type of association of solute and solvent which stands midway between solution and emulsion, because the body dwelling in the vehicle by its complete transparency would induce one to believe that it is dissolved, whereas on the contrary it is dispersed therein, in flakes, vesicles, or other shapes." (P. 41). He goes on to note that this is connected with the hydration of the particles, and that with time this hydration relaxes, "with the appearance of insoluble precipitate or of gelatin—an effect which shows itself more rapidly on addition of soluble salt in certain quantities, or other reagents." Selmi's observations on the smallness of the temperature and volume changes in colloid reactions, such as coagulation and dispersion, afford another notable example of his sound method of experiment and accurate grasp of the nature of colloids.

It would be easily possible to multiply quotations of striking interest from the papers reproduced. It must suffice to thoroughly recommend the book both to beginners in colloid chemistry and to more advanced students. They should both derive profit from its perusal.

The appearance of the book is dignified and it is printed on a rough paper, which makes it comfortable to read, although the type shows occasional degradation. The translations appear to be very happy and it is very seldom that an awkward phrasing may be noticed. The editing of this selection was entrusted to Mr. Emil Hatschek, the well-known colloid chemist and both he and his colleagues are to be heartily congratulated upon the issue.

S. E. SHEPPARD

The Teaching of Science and the Science Teacher. The Relationship of Science Teaching to Education in General, with Especial Reference to Secondary Schools and the Upper Elementary Grades. HERBERT BROWNELL AND FRANK B. WADE. The Century Company, New York and London, 1925. xi + 322 pp. 13.5 × 20.5 cm. $2.00.

As stated in the preface "this book is an outgrowth of the experiences of the authors—one as head of a science department (Chemistry) in a large city system and the other for many years engaged in fitting students to teach high-school sciences." Part I deals more specifically with method. The authors draw from their rich experiences and present many helpful suggestions

relating to technic of laboratory instruction, the use of text-books, class management, use of "projects," and examinations. There is in this part an attempt to develop an educational creed which shall guide in high-school science teaching and some discussion of what to teach and how to organize it. Part II is an attempt at analysis of the duties and the responsibilities of the science teacher. In this is discussed the teacher's need for professional preparation, and his responsibilities to the community. Separate chapters are devoted to the subjects; The Science Teacher as a Builder of Character, and Phases of Science Teaching in Moral Education. In the last chapter of Part II is given a discussion of the Status of High-School Science.

Part III consists of five chapters, one on each of the major divisions of science: (1) Science Below the High School, (2) General Science, (3) Biology, (4) Physics, (5) Chemistry. In Appendices are given (A) Lessons in Moral Training, (B) Black Finish for Tops of Laboratory Tables, (C) Range of Information Test, (D) Some Nature Study Lessons, (E) A Project of Chemistry.

The reviewer finds, particularly in the first part of the book many helpful suggestions. For the most part these relate to the routine of procedure. Throughout the book the authors display a genuine enthusiasm for their work. The reviewer does not find, however, that they have been influenced in any large measure by the recent developments in the educational field. Their interpretation of the "project" could not be accepted as valid by those who have been active in promoting this method of teaching. The chapter on Examinations suggests either that the authors are unfamiliar with what has been done in the field of educational tests or that they have chosen to ignore it. A footnote reference to two "Achievement Tests," one of which is not available for commercial distribution, is the only recognition given to the work which has been done in this field. The Range of Information Tests prepared by one of the authors and reproduced as Appendix C is quite inadequate as an illustration. The chapters on character building and on moral education develop a philosophy which educational psychologists could hardly accept and the relation of the discussion of moral education given in Appendix A to science education is not clear.

It is to be regretted that the work is not something more than a product of the authors' experiences. A book which in such large measure ignores the recent theoretical and scientific contributions can hardly be expected to occupy a place of importance in educational literature.

S. R. P.

TO BE REVIEWED LATER

Elements of Chemistry—Foster.

Laboratory Exercises in General Chemistry—Foster and Heath.

The States of Aggregation—Tammann.

Chemistry and Civilization—Cushman.

The Story of Copper—Davis.

Scholars of America Form Committee for Intellectual Coöperation.—An American committee to join with the scholars of twenty-five nations and the League of Nations in organizing international intellectual coöperation has been formed with Dr. Robert A. Millikan, Nobel prize winner in physics and president of the California Institute of Technology, as chairman.

This important group, merging for the first time in a formal way the scientific, artistic, literary, legal, educational, and other learned activities of the country, will collaborate with the International Institute of Intellectual Coöperation just established at Paris and the League of Nation's Committee on Intellectual Coöperation.

The first meeting of the American Committee on International Intellectual Cooperation will be called early this winter.

The membership of the committee includes: Dr. Millikan; Elihu Root, past president American Bar Association; George E. Hale, honorary chairman National Research Council; Charles H. Haskins, chairman of the Council of Learned Societies; Herbert Putnam, librarian of Congress and past president of the American Library Association; Virginia C. Gildersleeve, president International Federation of University Women; Lorado Taft, member of the American Academy of Arts and Letters; James H. Breasted, representative American philological organizations; Charles W. Eliot, president emeritus of Harvard University, representative American universities; Augustus Trowbridge, International Education Board; C. R. Mann, director American Council on Education, and Vernon Kellogg, permanent secretary National Research Council, secretary of the commission.—*Science Service*

A FEW MOMENTS WITH THE BUSINESS MANAGER

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I have found it very helpful because of the practical suggestions for high-school teaching as well as the information concerning new developments in chemistry.

Very truly yours,
PAULINE R. MEADER

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Chemistry in Industry was unusually interesting and the articles found in the magazines were exceptionally good.

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I am very interested in the JOURNAL and have used it frequently in my chemistry classes as a report of the latest things being done in chemistry.

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I am very much pleased to see the improvement in the JOURNAL and look forward to its arrival every month.

Yours very truly,
A. C. CHAMBERS

New Philadelphia, Ohio,
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It is a wonderful little magazine which not only contains articles of interest to me but to my chemistry pupils also. Some of the pupils have been using the articles in the English Department.

Yours truly,
L. E. HELMICK

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AUTHOR INDEX
Journal of Chemical Education

Volume 2, 1925

Articles:

ACKELSON, E. F. AND KIPLINGER, C. C. An Automatic Blast Lamp..... 784
ADAMS, C. S. The Antioch Plan of Co-operative Education as It Affects Students in Chemistry..... 900
ALLISON, E. R. Relation of Chemistry to National Defense..... 27
ANDEREGG, F. O. The Use of Problems in Teaching Colloid Chemistry..... 780
ARENTZ, F. B. Uses of Ethylene..... 459
ARMSTRONG, HENRY E. First Epistle of Henry the Chemist to the Uesanians 731

BAILEY, C. H. Teaching of Biochemistry. 130
BAKER, R. A. Museum Reactions..... 480
BEISLER, WALTER H. Some Chemical Products of Florida..... 437
BELL, J. E. What Are Our Objectives in Teaching Chemistry?..... 976
BENNETT, J. C. A Study of Pupil Errors in Chemistry..... 760
BINGHAM, EUGENE C. Helping the Metric Campaign..... 62
BIRD, K. L. AND BROWN, F. E. The Effects of Different Instructors for Recitation and Laboratory in Freshman Chemistry..... 102
BLUM, W. Teaching Principles of Electrodeposition..... 556
BOND, P. A. Report of Committee on Relationship between High-School and College Chemistry..... 269
BOTHE, ARTHUR H. An Analysis of High-School Texts in Chemistry..... 785
BOWERS, W. G. Place of Technical Work in an Elementary Chemistry Laboratory Manual..... 170
Some Suggestions as to the Selection of a Laboratory Manual for High-School Chemistry..... 605
BRANEGAN, JAS. A. Chemistry and Science in Prehistoric America..... 588
BRAUTLECHT, C. A. Manipulation of Gas Holders by Elementary Chemistry Students..... 486
Correlation of Lecture, Recitation, and Laboratory Work in General Chemistry..... 566
BRINKLEY, S. R. Problem Work in Elementary General Chemistry..... 136
Application of the Electron Concept to Oxidation-Reduction Reactions in General Chemistry..... 576
BROWN, F. E. AND BIRD, K. L. Effects of Different Instructors for Recitation and Laboratory in Freshman Chemistry..... 102
BROWNE, C. A. Thomas Paine's Theory of Atmospheric Contagion, etc..... 99
Practical Course in Agri. Chemistry for Elementary Students..... 240
The Life and Chemical Services of Fredrick Accum.....829, 1008, 1140
BROWNE, G. MERWIN. Some Suggested Changes in High-School Chemistry... 447
BROWNSCOMBE, EUGENE. Relation of Chemistry to the Development of Industries and Resources of California.. 11
BULLARD, R. H. Liquid Ammonia as a Solvent..... 924
BURDICK, ALFRED S. What the Chemist Does for the Druggist..... 677

CALVERT, ROBERT. Automobile Lacquer. 369
CARLSON, C. ALLEN. A Plan for the A. C. S. Prize Essay Contest..... 775
CHAPIN, W. H. Chemical Research Problems..... 391
CHAPIN, W. H. AND MAXSON, R. N. New Apparatus for Determining the Coefficient of Expansion of Gases..... 490
CLINTON, GUY. The Problem of High-School Chemistry..... 471
CONN, H. J. New Applications of Biological Stains..... 184
Dyes as Microchemical Reagents.... 753
CORDILL, SHIRLEY. The Relation of Chemistry to Health and Disease.... 1101
CORNOG, J. AND STODDARD, G. Predicting Performance in Chemistry..... 701
COURTINES, M. A Model of the Periodic Table..... 107
CROSSLEY, M. L. Training for the Profession of Chemistry..... 667
CUNNINGHAM, H. A. Types of Thought Questions in Chemistry Laboratory Manuals..... 167
CURRIER, A. J. High-School Chemistry: The Student's Viewpoint..... 113

DAVISON, H. F. The Art of Lecture Table Demonstrating..... 443
Safety First in Storing Chemicals.... 782
DELONG, CARL R. Synthetic Methanol—An Accomplishment of Chemical Research..... 429
DOANE, H. C. An Apparatus for Conductivity Experiments..... 487
DUTCHER, R. A. The Teaching of Biological Chemistry..... 127

EBAUGH, W. C. AND EVERHART, W. A. A Comparison of Grades in General Chemistry Earned by Students Who (*a*) Have Had and (*b*) Have Not Had High-School Chemistry..... 770
ENTRIKEN, J. B. AND HODGES, F. C. A Texas High-School Science Survey.. 199
ERWIN, ELEANOR. The Periodic Law.... 497
EVANS, W. L., PETERSON, HASS, HOFF, AND DAY. The Determination of the Formula of Carbon Dioxide..... 932
EVERHART, W. A. AND EBAUGH, W. C. A Comparison of Grades in General Chemistry Earned by Students Who (*a*) Have Had and (*b*) Have Not Had High-School Chemistry..... 770

FABER, H. B. Chemical Research in National Preparedness..... 61
FARSON, M. ELIZABETH. The Cinderella of the Metals..... 57
FERGUSON, A. The Course in High-School Chemistry. II..... 188
FILLINGER, HARRIETT H. A Painless Method..... 927
FINDLAY, ALEXANDER. The Appeal of Science to the Community..... 852
FOSTER, L. F. What Are Our Objectives in Teaching Chemistry?..... 977
FOSTER, WM. Chemistry in the French Lycées..... 43
A Century Old Chemistry Note-book 164
Some Novel Ideas in General Chemistry..... 289

Dr. Maclean and the Doctrine of Phlogiston 743
FRANK, J. O. The Objectives of High-School Chemistry 53
FRY, H. S. Questions Relative to the Correlation of College and High-School Chemistry Courses 260

GEAUQUE, H. A. A Classification of the Elements with Respect to Their Properties 464
GILE, P. L. The Chemical Nature of the Colloidal Soil Material 907
GLASOE, P. M. Introduction to the Systematic Treatment of First-Year Chemistry 449
GLENN, EARL R. The Need for Research on Problems of High-School Chemistry Instruction 670
GOOCH, W. T. The Application of the Slide Rule to Chemical Calculations .. 209
GORDON, N. E. Report of Committee of Chemical Education of A. C. S. 46
A Coöperative Plan in Chemical Education 72
GRAY, C. W. A Minimum or Maximum Course in Chemistry 235

HALL, ALTON L. The New Assistant 600
HANNEN, FRANK S. Summary of Records of Students' Work in Chemistry in Greeley High School 1924–25 912
HARRAR, NORMAN J. The Theory of Salt Craving 1054
HART, ED. Teaching Organic Chemistry. 109
HENDRICK, ELLWOOD. Catalysis—A New Factor in Industry 631
HENDRICKS, B. CLIFFORD. Finding and Salvaging the Superior Student 655
How We Teach Freshman College Chemistry 1187
HENWOOD, ABRAHAM. The Law of Avogadro 1061
HERTY, CHAS. H. The Future of the Synthetic Organic Chemical Industry in America 519
HIGLEY, G. O. An Adjustable Atomic Model 499
HIRSCHFELDER, A. D. The Direct Applications of Chemistry in the Study and Practice of Medicine 431
HODGES, F. C. AND ENTRIKEN, J. B. A Texas High-School Science Survey ... 199
HOLMES, HARRY N. Suggestions for Colloid Study 340
HONKE, MARION. The Relation of Chemistry to the Home 1121
HOPKINS, A. J. Method for the Calculation of Some Quantitative Problems 344
HOWARD, J. W. A System of Laboratory Instruction in Organic Chemistry 207
HOWE, H. E. Report of the Committee on Prize Essays, of the A. C. S. 1923–24 3
The Prize Essay Contest of 1924–25 1099

JACOBS, ADELINE H. Chemistry as Depicted in Art 111
Chemical Posters 792
JACOBSON, C. A. Chemical Spelling Stimulates Interest in Chemistry 462
JAMIESON, RUTH. The Relation of Chemistry to Agriculture 1111
JORDY, L. C. Mournful Numbers 756

KENDALL, JAMES. The Present Status of the Ionization Theory 374
The Calculation of the Formula of a Compound from Its Percentage Composition 495
KHARASCH, MORRIS S. Polar and Non-Polar Valences as Applied to Organic Chemistry 652
KILLEFFER, D. H. 1924 in Retrospect .. 74
KIPLINGER, C. C. AND ACKELSON, E. F. An Automatic Blast Lamp 784

KRAYBILL, H. R. The Place of Analytical Chemistry in Agriculture 120

LARSON, A. T. The Direct Synthesis of Ammonia 285
LEVINE, V. E. Suggestions to Teachers of Biological Chemistry. I 181
LEWIS, EDWIN H. Ballad of Ryerson 610
LIFE, FRANK M. The Science Teacher's Opportunity 1045
LITTLE, ARTHUR D. The Application of Research to Industry 959
LUFT, M. G. Rayon—Man-Made Silk .. 864

MAKEPEACE, ROGER S. The Relation of Chemistry to National Defense 1115
MANTELL, CHAS. L. AND ROGERS, ALLEN. Analytical Chemistry at Pratt Institute 681
MATTERN, LOUIS W. The Use of Charts and Graphs in Showing the Growth of Chemical Industries 640
MAXSON, R. N. AND CHAPIN, W. H. New Apparatus for Determining the Coefficient of Expansion of Gases 490
MCGILL, M. V. Open Meeting of the Chemistry Club of Lorain High School 294
MCLAUGHLIN, G. D. AND THEIS, E. R. Tanning as a Science 255
MELLON, M. G. Utilizing Recorded Chemistry 196
MICHENER, JOHN M. A Grading Help .. 488
MOORE, E. L. A New Method of Teaching Atoms and Molecules 248
MORGAN, W. C. What Are Our Objectives in Teaching Chemistry? 971
MUNROE, CHAS. E. Importance of Teaching Chemistry 67

NASON, EDITH. The Importance of Maintaining Interest in Chemistry in the Teaching of Students of Home Economics 386
NASSAU, BENJ. The Relation of Chemistry to the Home 22
NEVILLE, HARVEY A. Educating the Public in the Use of the Metric System 593
NEWELL, L. C. The Founders of Chemistry in America 48
Colonial Chemistry. I. New England 161
Benjamin Hale—Professor of Chemistry and College President 457
NIEUWLAND, J. A. The Orientation of Bonds of Tervalent Nitrogen 105
NORRIS, JAS. F. The A. C. S. and Education 229

OSBORNE, C. E. New Life in Old Chemistry 346
OSBORNE, RAYMOND W. Some Suggestions for Modifying the Content of High-School Chemistry to Better Serve the Purposes of a Liberal Education 737

PATTEE, E. N. The Effect of the Equal Pay for Teachers Bill in New York State 493
PIERCE, H. B. Should Teachers Do Research Work? 186
PIETERS, H. A. J. Chemistry in Holland 341
PITTMAN, O. C. The Relation of Chemistry to Agriculture and Forestry 17
POWERS, S. R. How Long Do Students Retain What They Have Learned from High-School Chemistry? 174
Some Problems of Curriculum and of Method of Instruction in High-School Chemistry 998
PRESTON, WALTER C. The Modern Soap Industry 1035, 1130

REID, JAS. C. The Relation of Chemistry to the Enrichment of Life 38

RICH, STEPHEN G. Some Misconceptions of Chemical Education..... 142
What Do Pupils Know of Chemistry When They Begin to Study It?.... 659
RODEBUSH, W. H. A Compact Arrangement of the Periodic Table..... 381
ROGERS, ALLEN. Chemistry and the Leather Industry..... 363
ROGERS, ALLEN AND MANTELL, C. L. Analytical Chemistry at Pratt Institute 681

SCHAEFFER, HAROLD F. Let's Be Consistent..... 1059
SCHLESINGER, H. I. What Are Our Objectives in Teaching Chemistry?.... 987
SEARS, GEO. W. Some Suggestions of the Past Year for Solving the Problems of First-Year Chemistry..... 146
SEGERBLOM, WILHELM. Apparatus Used by Dr. Morley..... 206
What Are Our Objectives in Teaching Chemistry?..... 994
SEMON, WALDO. The Standardization of Weights by Richards' Method..... 132
SILVERMAN, ALEXANDER. What Are Our Objectives in Teaching Chemistry?.. 984
SINGLETARY, HENRY S., JR. The Relation of Chemistry to the Enrichment of Life..... 1106
SMITH, E. F. Observations on Teaching the History of Chemistry..... 533
SMITH, H. R. Laboratory Study of Chemistry..... 231
Objectives in Teaching Chemistry.. 585
What Are Our Objectives in Teaching Chemistry?..... 991
SNELL, J. F. A Kindergarten Set for Illustrating the Diatomicity of the Familiar Gaseous Elements..... 190
SPENCER, JESSIE. The Teaching of Science in the High School..... 476
SPURGIN, WM. H. The Use of the True and the False Test in Chemistry Teaching..... 936
STEPHEN, RUTH. A Plea for Interest.... 141
STEWART, GEO. D. Chemistry in Medicine..... 191
STODDARD, G. AND CORNOG, J. Predicting Performance in Chemistry..... 701
STONE, CHAS. H. An Experiment in Teaching..... 119
Some Needed Improvements in Chemistry Texts..... 203
Nitrogen in War and Peace..... 275
Definitions..... 778
SUMMERS, JANE. The Relation of Chemistry to the Development of the Iron and Steel Industry in the United States..... 1125
SZYMANOWITZ, RAYMOND. Demonstration Apparatus for the Simultaneous Preparation of the Halogens..... 440

THEIS, E. R. AND MCLAUGHLIN, G. D. Tanning as a Science..... 255
THOMAS, ARTHUR W. The Modern Trend in Colloid Chemistry..... 323
THORBURN, A. D. A Century of Alkaloids 886
TURNER, R. G. Suggestions to the Teacher of Chemistry on Poisons and Their Treatment..... 466

VAIL, C. E. Celestial Chemistry..... 685
VAN VLEET, RUTH. Cross Word Puzzles in Hollywood High School..... 292
VILBRANDT, F. C. Study of Industrial Chemistry by the Unit Plant Research Development Method..... 748
VIVIAN, DON. L. The Relation of Chemistry to Health and Disease..... 32

WALKER, WALTER O. A Laboratory Note-Book..... 488
WEBB, H. A. Starting the Small Chemistry Laboratory..... 353
WHITE, C. E. A Demonstration Experiment of Electrolytic Oxidation and Reduction..... 208
WHITMORE, F. C. Group Examinations in Chemistry..... 441

ZIMMERMAN, J. ERNEST. The Value of Teaching Valence Prior to Balancing Chemical Equations..... 383

Abstracts:

AHLERS, LENA C. The Making of Soap.. 1200
June Visits a Glue Factory..... 1200
AMICK, C. A. The Necessity of Chemistry in High-School Training..... 409
ANDERSON, CARL W. Electric Production of Chlorine Gas..... 715
ANDREWS, J. B. Stop Coal Dust Explosions..... 714
ARDAGH, E. G. R. Simple Methods for Removing Frozen-In Glass Stopcocks and Stoppers..... 711
ARDAGH, E. G. R. AND DAVIDSON, A. L. Stop-Cock Lubrication and an Improved Lubricant..... 712
ARMSTRONG, H. E. The Making of a Compleat Chemyst..... 87
The Faraday Benzene Centenary..... 815
The Future Science of the Schools.... 940
Catalysis and Oxidation..... 1081
ASTON, F. W. The Isotopes of Mercury.. 1080

BAKER, L. H. The Handmaids of Medicine..... 1083
BAKER, R. A. Teaching Temperature Effects to Elementary Students..... 616
BALY, E. C. C. Photosynthesis..... 85
Reaction and Reactivity..... 944
Absorption Spectra and Chemical Constitution..... 1080
Photosynthesis of Naturally Occurring Compounds..... 1199
BARNARD, F. P. AND RACKEMANN, F. M. The Man Who Soothed the Brow of Agony..... 712
BARR, WM. M. Chemical Engineering Aspects of Water Treatment for Railroads..... 810
BAUDISCH, OSKAR AND WELS, LARS A. The Two-Stage Transformation of Magnetite into Hematite..... 943
BEARD, J. G. Education and Legislation 307
BEEBE, C. H. Relation between Industry and Chemical Warfare..... 216
BELLIS, BERTON. I Am a Chemist..... 712
BENEDICT, R. A. Opportunities for Science Teachers in New York High Schools..... 86
BERG, E. Teaching—A New Science.... 212
BLENCH, E. A. AND W. E. GARNER. Heat of Adsorption of Oxygen by Charcoal..... 150
BORNS, H. The Faraday Benzene Centenary and Kekulé..... 939
BOWERS, W. G. Grouping Students for Work in the Chemical Laboratory 306
The Character of Laboratory Work for Students of Elementary Chemistry..... 1201
BRAGG, W. L. The Carbon Atom in Crystalline Structure..... 149
Inorganic Crystals..... 710
The Crystalline Structure of Inorganic Salts..... 1080
BRAHAM, J. M. Trend of Developments in the Nitrogen Problem..... 88
BREEZE, RETHA E. Correcting Examination Papers..... 150
BROOKS, WENDELL S. The Rhodes Scholar's Ideal Professor..... 712
BRUCE, OSCAR C. Relation of Sulfur to Alfalfa Production..... 942
BRUNKOW, O. R., W. H. PETERSON, AND E. B. FRED. A Study of the Influence of Inoculation upon the Fermentation of Sauerkraut..... 942

BRYANT, P. L. Chinese Camphor and Camphor Oil 805
BUCKINGHAM, B. R. The Public School Teacher as a Research Worker 713
BUDD, T. A. Analyzing Cause of Student Failure 941
BURDGE, HOWARD G. Making the Regents' Examination 415
BUSWELL, A. M. Chemistry of Sewage Treatment 713

CADY, H. P. Liquid Air Plant at the University of Kansas 213
CALDWELL, O. W. The Elimination of Waste in Education 214
Service, the Needed Spirit of Modern Science Instruction 310
CALEY, EARLE R. How to Make a Chemical Flask Motor 614
CASON, H. AND E. B. CASON. Association Tendencies and Learning Ability 813
CHARTERS, W. W. Pure Research and Practical Research 1200
COHEN, ERNST. Faraday and His Contemporaries 815
COOPER, Z. M. Need for Teachers 307
The Three-Year Course 710
CURTIS, FRANCIS D. The Use of Text-Book and Syllabus Courses in General Science 613
CURTMAN, L. J., C. MARGULIES AND W. PLECHNER. New and Rapid Method for the Removal of Phosphates in Systematic Qualitative Analysis 807

DAVIDSON, A. L. AND ARDAGH, E. G. R. Stop-Cock Lubrication and an Improved Lubricant 712
DAVIS, ADA E. H. G. Wells on Education 1204
DAVIS, TENNEY L. Chemistry in War; An 18th Century Viewpoint 1082
DE KRUIF, PAUL. Jacques Loeb 806
DESCH, C. H. The Discipline of Chemistry 1200
DOYLE, H. G. Modern Foreign Language Study 1076
DRUCE, J. G. F. Some Recent Representations of the Periodicity of the Elements 612

EDMONDSON, J. D. Why High-School Pupils Fail 941
ELLIFF, J. D. Vocational Guidance Needed in Universities 941
EMERSON, HAVEN. Is This a Cure for Tuberculosis? 714

FAIRCHILD, MILTON. Effect of Methods of Instruction upon Character 614
FELZER, W. R. Chemical Fakes 414
FIEDLER, ALBAN. How Can We Humanize High-School Chemistry? 713
FIELD, E., A. HENWOOD, R. M. GAREY, AND W. GOLDBERG. Hydrogen Sulfide Gas; a Convenient Method for the Generation of Same 505
FIELDNER, A. C. AND R. R. SAYERS. Exhaust Gases from Engines Using Ethyl Gasoline 213
FINDLAY, ALEXANDER. The Twilight Zone of Matter 1082
FISCHER, FRANZ. The Coking and Swelling Constituents of Coal 710
FISCHER, MARTIN H. Science and Industry 154
FONDA, J. S. Historic Set of Weights 308
FOOTE, P. D. The Alchemist 85
FRANK, J. O. Aspects of Practice Teaching in the Preparation of Chemistry Teachers in a State Normal School .. 616
FRARY, F. C. The Electrolytic Refining of Aluminum 710
FRED, E. B., O. R. BRUNKOW, AND W. H. PETERSON. A Study of the Influence of Inoculation upon the Fermentation of Sauerkraut 942
FRIEND, J. NEWTON. The Periodic Sphere and the Position of the Rare Earth Metals 409
FUNK, C. AND HARROW, B. Instinct as a Guide to Food 715
FUSSLER, KARL. The Oneness of the Universe 812

GAMBLE, G. C. The Inquiring Mind in Education 416
GAREY, R. M., A. HENWOOD, W. GOLDBERG, AND E. FIELD. Hydrogen Sulfide Gas; a Convenient Method for the Generation of Same 505
GARNER, W. E. AND E. A. BLENCH. Heat of Adsorption of Oxygen by Charcoal 150
GASCHLER, A. The Transmutation of Uranium into Uranium-X 1202
GERNSBACK, H. Chance in Experimenting 508
GERRY, H. L. Measurements of the Results of the Teaching of Chemistry. 89
The Need and Use of a Scientific Measure of the Results of the Teaching of Chemistry 216
GILL, AUGUSTUS H. Anecdotes about Mysterious Explosions and Fires 612
GLASOE, P. M. High-School Chemistry and the Periodic System 85
GLENN, EARL R. AND JOSEPHINE WALKER. Bibliography of Science Teaching in Secondary Schools 1077
GOLDBERG, W., A. HENWOOD, R. M. GAREY AND E. FIELD. Hydrogen Sulfide Gas; a Convenient Method for the Generation of Same 505
GORIN, F. B. Technical Developments of the C. W. S. since the War 218
GREW, JOS. C. Waimaugu, and the Hot-Spring Country of New Zealand 811
GRIFFITH, I. The Ups and Downs of Nitrogen 1202

HALDANE, J. B. S. Chemistry and Peace 150
HARGREAVES, R. A Proposed Model for the Alpha Particle and Some Nuclear Series 942
HARKINS, W. D. AND S. B. STONE. The Isotopic Composition and the Atomic Weight of Chlorine in Meteorites 1202
HARRIGAN, M. H. Metric System in Schools 808
HARROW, B. AND FUNK, C. Instinct as a Guide to Food 715
HARROW, BENJ. Doctor Sunshine 811
HART, I. B. University of London's New M.Sc. Degree 214
The Physical Science of Leonardo da Vinci: A Survey 942
HENDERSON, E. V. Industrial Poisons .. 309
HENWOOD, A., R. M. GAREY, WOOLF GOLDBERG, AND E. FIELD. Hydrogen Sulfide Gas; a Convenient Method for the Generation of Same 505
HERRMANN, G. A. To Conserve Hydrogen Sulfide 1083
Chemical Apprentices 1203
HEVL, PAUL R. Fundamental Concepts 312
HIGBEE, H. H. Playing the Game in the College Class-room 509
HILL, E. VERNON. Basis of Physical Comfort in Relation to Air Temperature 938
Ox Cart or Auto—Which? 938
HILL, J. B. Research Problems Presented by the Petroleum Industry .. 617
HOLLINS, CECIL. Design of a Chemical Research Laboratory 505
HOLLISTER, H. A. Making Science Teaching More Effective in Relation to Life 713
HOLMYARD, E. J. Historical Method in School Science Courses 941
HOPKINS, A. J. Egypt, the Land of the Alchemists 1079
HOPKINS, B. S. The Training of Chem-

istry Teachers, Prospective and in Service..... 309
HOWALD, A. M. One-Movement Process for Impregnating Timber with Zinc Chloride and Petroleum Oils..... 613
HOWE, H. E. Chemical Literature..... 310
H. T. F. R. British Assoc. of Chemists—The Overcrowding of the Profession 714
The British Association of Chemists—The Title Chemist..... 615
HUGHES, A. L. AND F. E. POINDEXTER. Potassium as a Mercury-Vapor Trap 942
HUGHES, R. M. The Graduate Schools of America..... 712
HULTON, C. E. The Personal Element in Teachers' Marks..... 941
HUMPHREYS, W. J. The Way of the Wind 1078
HUNTER, G. W. The Place of Science in the Secondary School..... 709
HUTSON, P. W. High-School Science Teachers. A Study of Their Training in Relation to the Subjects They Are Teaching..... 85

JACOBS, THOS. R. Note on the Sealing of Carius Bomb-Tubes..... 612
JACOBSON, C. A. Chemical Spelling Continued..... 614
JOHNSON, T. A. The Results of the Application of Science in the Field of Medicine..... 507
JOHNSON, WARREN C. Elements of Glass Blowing and Demonstrations..... 507
JORDAN, C. J. The Tyranny of a Standardized Course of Study..... 415

KELSEY, T. D. Social Values of High-School Chemistry..... 411
KENDALL, ARTHUR I. Pioneering in the Chemistry of Microbes..... 507
KINDER, J. S. A Rating Scale for Practical Teachers..... 1204
KOOS, LEONARD V. Overlapping in High School and College..... 714
KREMERS, H. C. Chlorine for Colds.... 305
KUEBLER, JOHN R. Pasteur..... 510

LEEKER, W. R. The Articulation of General Science with the Special Sciences 510
LEWIS, W. K. Chemical Engineering.... 808
LINT, HENRY C. Sulfur. An Industrial Necessity..... 414
LONG, J. S. Chemical Laboratory Study 150
LUCKEY, G. W. A. International Education Research Council and World Bureau of Education..... 1078
LYMAN, R. A. Three-Year Course in Pharmacy..... 812

MACRAE, A. E. Bacteriological Chemistry and Industry..... 711
MALIM, F. B. The Training of Teachers.. 1201
MALPAS, JOHN. The Business Value of Chemistry in Education..... 807
MANLEY, J. J. Mercury Halide: A Correction..... 814
MANNHEIMER, E. Experiment on Catalysis..... 306
MANSFIELD, WM. Report of the Section of Education and Legislation, A. Ph. A..... 413
MARVIN, F. S. Humanism in Science Teaching..... 941
MASON, C. W. Metallography as a Study for Chemists..... 414
MAZUROWSKA, M. Public Education in Poland..... 87
MCCONAUGHY, J. L. Individuality and Uniformity in Education..... 806
MEES, C. E. K. Significant Progress in Research in Photography..... 806
MERRICK, A. T. Speeds of Atomic Particles..... 508
MILLIKAN, ROBERT A. The Astronomy of the Atom..... 86
The Electron and Light Quanta—What Are They?..... 151
MINER, J. B. A New Type of College Course..... 1076
MOORE, H. K. Complexities of the Industrial Chemist (Perkin Medal Address)..... 212
MOORE, R. C. Two Engineers and Their Power Plants..... 1200

NAGAOKA, H. Preliminary Note on the Transmutation of Mercury into Gold 939
NAKAHARA, W. Tissue Transplantation. 806
NEEDHAM, JOSEPH. The Philosophical Basis of Biochemistry..... 716
NEVILLE, HARVEY A. Chemical Quackery 709
An Outline of Obesity..... 713
NEWHALL, C. A. Refined Sulfurs: Their Manufacture and Uses..... 810
NEWSON, J. R. A Simple Toepler Pump.. 615
NICHOLS, WM. H. Fifty Years of Chemistry in America..... 87
NOYES, W. A. Training the Chemist—A Critical Survey..... 308
The Chemical Warfare Service and Pacifism..... 712
Recent Developments in Photo-Chemistry..... 714

OBOURN, ELLSWORTH S. the Possibilities of a "Burned Out" Electric Light Bulb in General Science..... 613
OHMANN, O. Experiment; the Approximate Evaluation of Explosion Mixtures..... 307
Experiments with Explosive Gas Mixtures..... 506
OLDROYD, C. A. U-Tube Gas Generator.. 715
ORR, J. B. The Mineral Elements in Animal Nutrition..... 1199
OWENS, KATHERINE AND W. PERRY. A Ninth Grade Course in General Science..... 613

PARKS, W. A. Cultural Aspects in Geology..... 1202
PATTERSON, D. G. Value of the Photograph in Judging Human Character.. 1203
PEIRCE, W. M., *et al.* Allotropy of Zinc.. 1077
PERRY, WINIFRED AND K. OWENS. A Ninth Grade Course in General Science..... 613
PERVIER, N. C. The Training of Chemists in the University of Minnesota.. 308
PETERSON, W. H E., B. FRED, AND BRUNKOW, O. R. A Study of the Influence of Inoculation upon the Fermentation of Sauerkraut..... 942
PICKLES, ALWYN. Thoroughness in Science Teaching..... 151
PIEPER, CHARLES J. Supervised Study in Natural Science..... 86
POINDEXTER, F. E. AND A. L. HUGHES. Potassium as a Mercury-Vapor Trap 942
POPE, W. J. Faraday as a Chemist..... 815
POWERS, S. R. Achievement in High-School Chemistry—An Examination of the Subject-Matter..... 151
The Vocabularies of High-School Science Textbooks..... 215
POWERS, W. G. Some Educational Values in Laboratory Work..... 149
PRESCOTT, S. C. Chemistry and Sanitation at Mass. Homeopathic Med. Soc. 944
PROCTOR, CHAS. H. The Manufacture of Tinsel..... 412
PUPIN, M. I. The Meaning of Scientific Research..... 217

RACKEMANN, F. M. AND F. P. BARNARD, The Man Who Soothed the Brow of Agony..... 712
RADCLIFFE, H. H. Making the Laboratory the Basis of High-School Science 1201
RANDALL, OTIS E. Some Essentials in the Process of Preparing for College.... 1078

RAUTH, JOHN W. A Study of the Achievement of High-School Students in Chemistry 716
REDMAN, S. L. Classification and Eligibility 614
RICH, S. G. Achievements of Pupils in Chemistry 215
RICHMOND, C. A. The Place of Religion in Higher Education 509
RILEY, C. F. CURTIS. Educational Value of Nature Study 709
ROARK, M. L. Is the Project Method a Contribution? 416
ROBERTS, C. E. BECHHOFER. The Almighty Atom 938
ROBINSON, R. X-Ray Crystal Analysis as an Auxiliary in Organic Chemical Research 938
ROGERS, JAMES HARVEY. Uniform Grading System 1078
RUCH, G. M. College Qualifying Examinations 709
RUDD, W. F. Education for Profit 1202
RUSBY, H. H. The Correlation of Pharmaceutical and Medical Education .. 812
RUSSELL, A. S. Transformation of Mercury into Gold 1081
RUTHERFORD, SIR ERNEST. The Natural and Artificial Disintegration of the Elements 149
Mosely's Work on X-Rays 1081

SALTER, C. H. Report on Evaluation of Objectives in Chemistry by Teachers in Cleveland, Ohio, Schools and Information Test of Pupils 505
Report on Chemistry 812
SALZBERG, PAUL L. The Inter-Relation of the Sciences 713
SANGER, W. T. Certification of Teachers in Virginia 305
SAYERS, R. R. AND A. C. FIELDNER. Exhaust Gases from Engines Using Ethyl Gasoline 213
SCHAAR, B. E. Symposium Chemical Warfare Service 615
The Significance of Dayton 1077
SCHUELER, J. L. A New Method of Zinc Coating Wire 1203
SCHWANTKE, CHRISTOPHER. Home-made Models of Technical Apparatus in the Class-room 411
SEASHORE, C. E. College Placement Examinations 88
SEAVERNS, JOHN A. Ethics and the Test Tube 412
SEYBOLD, G. B. The Atom's Amazing Secret of Power Near Solution 809
SHAPIRO, A. A. Resectioning Students According to Efficiency 416
SHOWALTER, WM. J. Interviewing the Stars 151
SLOSSON, E. E. Science Teaching in a Democracy 87
Artificial Gasoline 213
Artificial Gold 216
New Germicides 305
Artificial Food 509
SMITH, H. R. Chemical Education 214
The Lecture Method 1203
SMYTH, CHAS. P. Refractions and Electron Constraint in Ions and Molecules 942
SNAVELY, GUY E. A Standard Liberal Arts College 709
STABBER, HERMAN. Fluorescein an Aid to Tracing Waters Underground 310
STARK, W. E. When the Scientific Mind Meets Popular Prejudice 416
STEPPAT, MARGARET. The Histrionic Nature of Teaching 812
STERN, R. Teaching Chemistry to Beginners along Historical Lines 941
STONE, S. B. AND W. D. HARKINS. The Isotopic Composition and the Atomic Weight of Chlorine in Meteorites 1202
STROUP, F. P. Chemistry in and about the Home 1202

TAYLOR, HOWARD. College Curricula and Social Institutions 807
T. C. Metal Resources and the Constitution of the Earth 814
TEEPLE, J. E. Partnership of Business and Chemistry 413
TERMAN, L. M. The Possibilities and Limitations of Training 149
TETLOW, HENRY. Art of the Perfumer .. 715
War Paint 807
THOMSON, ELIHU. Fused Silica 1081
THORPE, J. F. The Discovery of Benzene 815
THWING, CHAS. F. The Superior Student in College 1079
TIDYMAN, W. F. Adjusting Marking Systems to Differences in Groups 1078
TRIPP, E. N. The Discovery of Benzene 814
TUPHOLME, C. H. S. Synthetic versus By-Product Ammonia in Europe 711
TURNER, J. E. Nature and Ultranature .. 1204
TUTTON, A. E. H. Obituary of Sir Edward Thorpe 411
TWISS, GEO. R. Status of Science Education in China 215

UNZICKER, SAMUEL. Teachers' Marks and Intelligence 416
U. S. BUREAU OF STANDARDS VISITING COMMITTEE. Value of Industrial Research 808

VAUGHAN, W. W. Warp and Woof in Education 1079
VIEWEG, HERMAN. Geology and Chemistry 414
VOGEL, JULIUS L. F. Notes on Alloy Metals Used in Alloy Steels 216

WALKER, H. W. Chemical Warfare and the Boll Weevil Problem 412
WALKER, JOSEPHINE AND GLENN, EARL R. Bibliography of Science Teaching in Secondary Schools 1077
WALTON, J. H. Chemistry Books for the High-School Library 411
WELS, LARS AND BAUDISCH, OSKAR. The Two-Stage Transformation of Magnetite into Hematite 943
WEST, J. H. A New Acid-Resisting Material 616
WEST, PERRY. Modern Trend in the Science of Ventilation 153
WHELPLEY, J. M. The Tenth Revision of the U. S. Pharmacopoeia 710
WHIDDINGTON, R. Discharge of Electricity through Vacuum Tubes 1200
WHITAKER, M. C. The Future of Alcohol Motor Fuels 1076
WHITMAN, W. G. An Inexpensive Footlight Dimmer 805
WOODHULL, JOHN F. Natural Science by the Experimental Method 805
WOLF, A. G. Sulfur 151
WULLING, F. J. Character Tests for Pharmacy Entrants 216
Pharmacy Teacher Training 1202

ZEITLER, H. An Introduction to Chemical Technology in the Chemistry Course 306

SUBJECT INDEX
Journal of Chemical Education

Volume 2, 1925

Articles:

A. C. S. Prize Essay Contest, A Plan for the. Carlson, C. Allen..... 775
Adjustable Atomic Model, An. Higley, G. O..... 499
Agricultural Chemistry for Elementary Students, A Practical Course in. Browne, C. A..... 240
Agriculture and Forestry, The Relation of Chemistry to. Pittman, Oliver C... 17
Agriculture, Place of Analytical Chemistry in. Kraybill, H. R..... 120
Agriculture, The Relation of Chemistry to. Jamieson, Ruth..... 1111
Alkaloids, A Century of. Thorburn, A. D. 886
American Chemical Society and Education, The: Norris, Jas. F..... 229
American Chemical Society, Report of the Committee on Prize Essays of the—1923–1924. Howe, H. E..... 3
Ammonia, The Direct Synthesis of—A Lecture Table Experiment. Larson, A. T..... 285
Ammonia as a Solvent, Liquid. Bullard, R. H..... 924
Analysis of High-School Texts in Chemistry, An. Bothe, Arthur H..... 785
Analytical Chemistry in Agriculture, The Place of. Kraybill, H. R..... 120
Analytical Chemistry at Pratt Institute—A Combination Course in Qualitative and Quantitative Analysis. Mantell, Chas. L. and Rogers, Allen..... 681
Antioch Plan of Coöperative Education as It Affects Students in Chemistry, The. Adams, C. S..... 900
Apparatus for Conductivity Experiments, An. Doane, H. C..... 487
Apparatus Used by Dr. Morley. Segerblom, W..... 206
Appeal of Science to the Community, The. Findlay, Alexander..... 852
Application of the Electron Concept to Oxidation-Reduction Reactions in General Chemistry. Brinkley, S. R.. 576
Application of Research to Industry, The. Little, A. D..... 959
Application of the Slide Rule to Chemical Calculations, The. Gooch, W. T.... 209
Art, Chemistry as Depicted in. Jacobs, Adeline H..... 111
Art of Lecture Table Demonstrating, The. Davison, H. F..... 443
Atomic Model, An Adjustable. Higley, G. O..... 499
Atoms and Molecules, A New Method of Teaching. Moore, Ed. L..... 248
Automatic Blast Lamp, An. Ackelson, E. F., and Kiplinger, C. C..... 784
Automobile Lacquer. Calvert, Robt..... 369
Avogadro, The Law of. Henwood, Abraham..... 1061

Bakelite. Bakelite Corporation..... 1153
Balancing Chemical Equations, The Value of Teaching Valence Prior to. Zimmerman, J. A. E..... 383
Ballad of Ryerson. Lewis, E. H..... 610
Benjamin Hale—Professor of Chemistry and College President. Newell, Lyman C..... 457
Biochemistry, The Teaching of. Bailey, C. H..... 130
Biological Chemistry, Suggestions to Teachers of. I. The Classification of Lipins. Levine, V. E..... 181
Biological Chemistry, The Teaching of. Dutcher, R. A..... 127
Biological Stains, New Applications of. Conn, H. J..... 184
Blast Lamp, An Automatic. Ackelson, E. F. and Kiplinger, C. C..... 784
Bonds of Tervalent Nitrogen, The Orientation of the. Nieuwland, J. A..... 105

Calculation of the Formula of a Compound from Its Percentage Composition, The. Kendall, Jas..... 495
Calculation of Some Quantitative Problems, A Method for the. Hopkins, A. J..... 344
Carbon Dioxide, The Determination of the Formula of. Evans, W. L., *et al.*..... 932
Catalysis—A New Factor in Industry. Hendrick, Ellwood..... 631
Catalytic Oxidation of Benzene to Maleic Acid. Weiss and Downs..... 1178
Celestial Chemistry. Vail, C. E..... 685
Century of Alkaloids, A. Thorburn, A. D. 886
Century Old Chemistry Note-Book, A. Foster, Wm..... 164
Changes in High-School Chemistry, Some Suggested. Browne, Geo. M..... 447
Charts and Graphs in Showing the Growth of Chemical Industries, The Use of. Mattern, L. W..... 640
Chemical Calculations, The Application of the Slide Rule to. Gooch, W. T..... 209
Chemical Education of A. C. S., Report of Committee of. Gordon, N. E..... 46
Chemical Education, A Coöperative Plan in. Gordon, N. E..... 72
Chemical Education, Some Misconceptions of. Rich, S. G..... 142
Chemical Industries, The Use of Charts and Graphs in Showing the Growth of. Mattern, L. W..... 640
Chemical Nature of the Colloidal Soil Material, The. Gile, P. L..... 907
Chemical Posters. Jacobs, Adeline H... 792
Chemical Products of Florida, Some. Beisler, W. H..... 437
Chemical Research Problems. Chapin, W. H..... 391
Chemical Research in National Preparedness. Faber, H. B..... 61
Chemical Spelling. Jacobson, C. A..... 462
Chemistry in America, The Founders of. Newell, L. C..... 48
Chemistry, Celestial. Vail, C. E..... 685
Chemistry Club of Lorain High School, Open Meeting of the. McGill, M. V. 294
Chemistry, Colonial. I. New England. Newell, L. C..... 161
Chemistry Courses, Questions Relative to the Correlation of College and High-School—. Fry, H. S..... 260
Chemistry as Depicted in Art. Jacobs, Adeline H..... 111
Chemistry in the French Lycées. Foster, Wm..... 43
Chemistry, High-School: The Student's Viewpoint. Currier, A. J..... 113
Chemistry in Holland. Pieters, H. A. J... 341

Chemistry, Importance of Teaching. Munroe, C. E. 67
Chemistry Information Bureau, A. Goodell, F. E. 937
Chemistry Laboratory, Starting the Small. Webb, H. A. 353
Chemistry, The Laboratory Study of. Smith, H. R. 231
Chemistry Laboratory Manual, The Place of Technical Work in an Elementary—. Bowers, W. G. 170
Chemistry Laboratory Manuals, Types of Thought Questions in. Cunningham, H. A. 167
Chemistry and the Leather Industry. Rogers, Allen 363
Chemistry in Medicine. Stewart, G. D. 191
Chemistry, A Minimum or Maximum Course in. Gray, Carl W. 235
Chemistry, The Objectives of High-School. Frank, J. O. 53
Chemistry and Science in Pre-Historic America. Branegan, J. A. 588
Chemistry, Teaching Organic. Hart, Ed. 109
Chemistry Texts, Some Needed Improvements in. Stone, Chas. H. 203
Chemistry, Utilizing Recorded. Mellon, M. G. 196
Cinderella of the Metals, The. Farson, M. E. 57
Classification of the Elements with Respect to Their Properties. Geauque, H. A. 464
Classification of Lipins, The. Suggestions to Teachers of Biological Chemistry: Levine, V. E. 181
Class-room Emanations....408, 501, 611, 1196
Coefficient of Expansion of Gases, New Apparatus for Determining. Chapin, W. H. and Maxson, R. N. 490
Colloid Chemistry, The Modern Trend in. Thomas, A. W. 323
Colloid Chemistry, The Use of Problems in Teaching. Anderegg, F. O. 780
Colloid Study, Suggestions for. Holmes, H. N. 340
Colloidal Soil Material, The Chemical Nature of the. Gile, P. L. 907
Colonial Chemistry. I. New England. Newell, L. C. 161
Compact Arrangement of the Periodic Table, A. Rodebush, W. H. 381
Comparison of Grades in General Chemistry Earned by Students Who (*a*) Have Had and (*b*) Have Not Had High-School Chemistry, A. Everhart, W. A. and Ebaugh, W. C. 770
Conductivity Experiments, An Apparatus for. Doane, H. C. 487
Content of High-School Chemistry. Some Suggestions for Modifying the—to Better Serve the Purposes of a Liberal Education. Osborne, Raymond W. . 737
Coöperative Education as It Affects Students in Chemistry, The Antioch Plan of. Adams, C. S. 900
Coöperative Plan in Chemical Education, A. Gordon, N. E. 72
Correlation of College and High-School Chemistry Courses, Questions Relative to the. Fry, H. S. 260
Correlation of Lecture, Recitation, and Laboratory Work in General Chemistry. Brautlecht, C. A. 566
Course in High-School Chemistry, The. Ferguson, A. 188
Court of Chemical Achievement:
(1) Proteins from Beef Blood 1150
(2) Electrolytic White Lead, Zinc Recovery 1151
(3) Bakelite 1153
(4) Optical Glass 1155
(5) Permalloy 1157
(6) Pyrex 1158
(7) Crodon: The New Chrome Alloy Plate 1160
(8) Duco, Oval Shotgun Powder, Low Freezing Dynamite, Rubber Accelerators, Dyes 1161
(9) Some Recent Accomplishments of the Chemical Warfare Service 1163
(10) Synthetic Organic Chemicals 1167
(11) Metallic Tantalum 1168
(12) Heat-Enduring Alloy 1170
(13) Karolith 1171
(14) Isotopes of Chlorine and Mercury and Apparatus for Their Production .. 1173
(15) Furfural 1175
(16) Latex Spraved Rubber 1176
(17) Catalytic Oxidation of Benzene to Maleic Acid 1178
(18) Chemical Achievements of U. S. Department of Agriculture 1180
Crodon: The New Chrome Alloy Plate. Chemical Treatment Co., Inc. 1160
Curriculum and Method of Instruction in High-School Chemistry, Some Problems of. Powers, S. R. 998

Definitions. Stone, Chas. H. 778
Demonstration Apparatus for the Simultaneous Preparation of the Halogens. Szymanowitz, R. 440
Demonstration Experiment of Electrolytic Oxidation and Reduction, A. White, C. E. 208
Determination of the Formula of Carbon Dioxide, The. Evans, W. L., *et al.* .. 932
Development of the Industries and Resources of Calif., The Relation of Chemistry to the. Brownscombe, Eugene 11
Diatomicity of the Familiar Gaseous Elements, A Kindergarten Set for Illustrating the. Snell, J. F. 190
Different Instructors for Recitation and Laboratory in Freshman Chemistry, The Effects of. Brown, F. E. and Bird, K. L. 102
Direct Applications of Chemistry in the Study and Practice of Medicine, The. Hirschfelder, A. D. 431
Direct Synthesis of Ammonia, The. A Lecture Table Experiment. Larson, A. T. 285
Disease, The Relation of Chemistry to Health and. Cordill, Shirley 1101
Disease, The Relation of Chemistry to Health and. Vivian, Don. L. 32
Dr. Maclean and the Doctrine of Phlogiston. Foster, Wm. 743
Dr. Morley, Apparatus Used by. Segerblom, W. 206
Druggist, What the Chemist Does for the. Burdick, A. S. 677
Duco, Oval Shotgun Powder, Low-freezing Dynamite, Rubber Accelerators, Dyes. E. I. du Pont de Nemours & Co., Inc. 1161
Dyes as Microchemical Reagents. Conn, H. J. 753

Educating the Public in the Use of the Metric System. Neville, H. A. 593
Education, The American Chemical Society and. Norris, Jas. F. 229
Education, A Coöperative Plan in Chemical. Gordon, N. E. 72
Effect of the Equal Pay for Teachers' Bill in New York State, The. Pattee, E. N. 493
Effects of Different Instructors for Recitation and Laboratory in Freshman Chemistry. Brown, F. E. and Bird, K. L. 102
Electrodeposition, Teaching Principles of. Blum, W. 556
Electrolytic Oxidation and Reduction, A Demonstration Experiment of. White, C. E. 208
Electrolytic White Lead, Zinc Recovery. Anaconda Copper Mining Co. 1151

Electron Concept, Application of the—to Oxidation-Reduction Reactions in General Chemistry. Brinkley, S. R. 576
Elements, Classification of the—with Respect to Their Properties. Geauque, H. A. 464
Ethylene, Uses of. Arentz, F. B. 459
Examinations in Chemistry, Group. Whitmore, F. C. 441
Experiment in Teaching, An. Stone, Chas. H. 119

Finding and Salvaging the Superior Student. Hendricks, B. C. 655
First Epistle of Henry the Chemist to the Uesanians, The. Armstrong, H. E. 731
Forestry, The Relation of Chemistry to Agriculture and. Pittman, Oliver C. 17
Formula of Carbon Dioxide, The Determination of the. Evans, W. L., *et al.* 932
Formula of a Compound, The Calculation of the—from Its Percentage Composition. Kendall, Jas. 495
Founders of Chemistry in America, The. Newell, L. C. 48
Fredrick Accum, The Life and Chemical Services of. Browne, C. A. 829, 1008, 1140
French Lycées, Chemistry in the. Foster, Wm. 43
Furfural. The Miner Laboratories 1175
Future of the Synthetic Organic Chemical Industry in America, The. Herty, Chas. H. 519

Gases, New Apparatus for Determining the Coefficient of Expansion of. Chapin, W. H. and Maxson, R. N. 490
Gas Holders, Manipulation of—by Elementary Chemistry Students. Brautlecht, C. A. 486
General Chemistry, Problem Work in Elementary. Brinkley, S. R. 136
General Chemistry, Some Novel Ideas in. Foster, Wm. 289
Grades in General Chemistry Earned by Students Who (*a*) Have Had and (*b*) Have Not Had High-School Chemistry, A Comparison of. Everhart, W. A., and Ebaugh, W. C. 770
Grading Help, A. Michener, J. A. 488
Group Examinations in Chemistry. Whitmore, F. C. 441
Growth of Chemical Industries, The Use of Charts and Graphs in Showing the. Mattern, L. W. 640

Hale, Benjamin—Professor of Chemistry and College President. Newell, Lyman C. 457
Halogens, Demonstration Apparatus for the Simultaneous Preparation of the. Szymanowitz, R. 440
Health and Disease, The Relation of Chemistry to. Cordill, Shirley 1101
Health and Disease, The Relation of Chemistry to. Vivian, Don. L. 32
Heat-Enduring Alloy Resisting the Action of Alkali Compounds under Oxidizing Conditions at 2150°F. Victor Hybinette 1170
Helping the Metric Campaign. Bingham, E. C. 62
High-School Chemistry, The Course in. II. Ferguson, A. 188
High-School Chemistry Instruction, The Need for Research on Problems of. Glenn, E. R. 670
High-School Chemistry, The Objectives of. Frank, J. O. 53
High-School Chemistry, The Problem of. Clinton, Guy 471
High-School Chemistry: The Student's Viewpoint. Currier, A. J. 113
High-School Texts in Chemistry, An Analysis of. Bothe, Arthur H. 785
History of Chemistry, Observations on Teaching the. Smith, E. F. 533
Home Economics, The Importance of Maintaining Interest in Chemistry in the Teaching of Students of. Nason, Edith 386
Home, The Relation of Chemistry to the. Honke, Marion 1121
Home, The Relation of Chemistry to the. Nassau, Benj. 22
How Long Do Students Retain What They Have Learned from High-School Chemistry? Powers, S. R. 174
How We Teach Freshman College Chemistry. Hendricks, B. C. 1187

Importance of Maintaining Interest in Chemistry in the Teaching of Students of Home Economics, The. Nason, Edith 386
Importance of Teaching Chemistry. Munroe, C. E. 67
Industrial Chemistry by the Unit Plant Research Development Method, Study of. Vilbrandt, Frank C. 748
Industries and Resources of Calif., The Relation of Chemistry to the Development of the. Brownscombe, Eugene. 11
Information Bureau, A Chemistry. Goodell, F. E. 937
Introduction to the Systematic Treatment of First-Year Chemistry. Glasoe, P. M. 449
Ionization Theory, The Present Status of the. Kendall, Jas. 374
Iron and Steel Industry in the United States, The Relation of Chemistry to the Development of the. Summers, Jane 1125
Isotopes of Chlorine and Mercury and Apparatus for Their Production. Kent Chemical Lab., Univ. of Chicago. 1173

Joint Meeting of the Division of Chemical Education and the Section of History of Chemistry at the Los Angeles Meeting of the A. C. S. Sears, G. W. 879

Karolith—The American Casein Plastic. Karolith Corporation 1171
Kindergarten Set for Illustrating the Diatomicity of the Familiar Gaseous Elements, A. Snell, J. F. 190

Laboratory Manual for High-School Chemistry, Some Suggestions as to the Selection of a. Bowers, W. G. 605
Laboratory Note-Book, A. Walker, W. O. 489
Laboratory Study of Chemistry, The. Smith, H. R. 231
Latex Sprayed Rubber. U. S. Rubber Co. 1176
Law of Avogadro, The. Abraham Henwood 1061
Leather Industry, Chemistry and the. Rogers, Allen 363
Lecture Table Demonstrating, The Art of. Davison, H. F. 443
Let's Be Consistent. Schaeffer, Harold F. 1059
Liberal Education, Some Suggestions for Modifying the Content of High-School Chemistry to Better Serve the Purposes of a. Osborne, Raymond W. 737
Life and Chemical Services of Fredrick Accum, The. Browne, C. A. 829, 1008, 1140
Life, The Relation of Chemistry to the Enrichment of. Reid, Jas. C. 38
Life, The Relation of Chemistry to the Enrichment of. Singletary, H. S., Jr. 1106
Lipins, The Classification of—Suggestions to Teachers of Biological Chemistry. Levine, V. E. 181
Liquid Ammonia as a Solvent. Bullard, R. H. 924

Manipulation of Gas Holders by Elementary Chemistry Students. Brautlecht, C. A. 486

Medicine, Chemistry in. Stewart, G. D. 191
Medicine, The Direct Applications of Chemistry in the Study and Practice of. Hirschfelder, A. D. 431
Metallic Tantalum. Fansteel Products Co. 1168
Metals, The Cinderella of the. Farson, M. E. 57
Methanol, Synthetic—An Accomplishment of Chemical Research. DeLong, Carl R. 429
Method for the Calculation of Some Quantitative Problems, A. Hopkins, A. J. 344
Method of Instruction in High-School Chemistry, Some Problems of Curriculum and of. Powers, S. R. 998
Metric Campaign, Helping the. Bingham, E. C. 62
Metric Play, A—The New Assistant. Hall, A. L. 600
Metric System, Educating the Public in the Use of the. Neville, H. A. 593
Microchemical Reagents, Dyes as. Conn, H. J. 753
Minimum or Maximum Course in Chemistry, A. Gray, Carl W. 235
Minutes of the Baltimore Meeting 404
Model of the Periodic Table, A. Courtines, M. 107
Modern Soap Industry, The. Preston, Walter C. 1035, 1130
Modern Trend in Colloid Chemistry, The. Thomas, A. W. 323
Mournful Numbers. Jordy, Louis C. 756
Museum Reactions. Baker, R. A. 480

National Defense, The Relation of Chemistry to. Allison, Elton R. 27
National Defense, The Relation of Chemistry to. Makepeace, Roger S. 1115
Need for Research on Problems of High-School Chemistry Instruction, The. Glenn, E. R. 670
New Apparatus for Determining the Coefficient of Expansion of Gases. Chapin, W. H. and Maxson, R. N. 490
New Applications of Biological Stains. Conn, H. J. 184
New Assistant, The—A Metric Play. Hall, A. L. 600
New Life in Old Chemistry. Osborne, C. E. 346
New Method for Teaching Atoms and Molecules, A. Moore, Ed. L. 248
Nitrogen, The Orientation of the Bonds of Tervalent. Nieuwland, J. A. 105
Nitrogen: In War and Peace. Stone, Chas. H. 275
Note-Book, A Century Old Chemistry. Foster, Wm. 164
Note-Book, A Laboratory. Walker, W. O. 489

Objectives of High-School Chemistry, The. Frank, J. O. 53
Objectives in Teaching Chemistry. Smith, H. R. 585
Objectives in Teaching Chemistry? Symposium: What Are Our.
(1) Wm. C. Morgan 971
(2) J. E. Bell 976
(3) L. F. Foster 977
(4) Alexander Silverman 984
(5) H. I. Schlesinger 987
(6) H. R. Smith 991
(7) Wilhelm Segerblom 994
Observations on Teaching the History of Chemistry. Smith, E. F. 533
Old Chemistry, New Life in. Osborne, C. E. 346
Open Meeting of the Chemistry Club of Lorain High School. McGill, M. V. 294
Opportunity, The Science Teacher's. Life, Frank M. 1045
Optical Glass. Bausch & Lomb Optical Co. 1155
Organic Chemical Industry in America, The Future of the Synthetic. Herty, Chas. H. 519
Organic Chemistry, Polar and Non-Polar Valences as Applied to. Kharasch, M. S. 652
Organic Chemistry, A System of Laboratory Instruction in. Howard, J. W. 207
Organic Chemistry, Teaching. Hart, Ed. 109
Orientation of the Bonds of Tervalent Nitrogen, The. Nieuwland, J. A. 105
Oxidation and Reduction, A Demonstration Experiment of Electrolytic. White, C. E. 208
Oxidation-Reduction Reactions in General Chemistry, Application of the Electron Concept to. Brinkley, S. R. 576

Painless Method, A. Fillinger, Harriett H. 927
Pay for Teachers' Bill in New York State, The Effect of the Equal. Pattee, E. N. 493
Performance in Chemistry, Predicting. Cornog, Jacob and Stoddard, G. D. 701
Periodic Law, The—A Bedtime Story for Wide Awake Children. Erwin, Eleanor 497
Periodic Table, A Compact Arrangement of. Rodebush, W. H. 381
Periodic Table, A Model of the. Courtines, M. 107
Permalloy. Bell Telephone Laboratories, 1157
Phlogiston, Dr. Maclean and the Doctrine of. Foster, Wm. 743
Place of Analytical Chemistry in Agriculture, The. Kraybill, H. R. 120
Place of Technical Work in an Elementary Chemistry Laboratory Manual, The. Bowers, W. G. 170
Plan for the A. C. S. Prize Essay Contest, A. Carlson, C. Allen 775
Plea for Interest, A. Stephen, Ruth 141
Poisons and Their Treatment, Suggestions to the Teacher of Chemistry on. Turner, R. G. 466
Polar and Non-Polar Valences as Applied to Organic Chemistry. Kharasch, M. S. 652
Practical Course in Agricultural Chemistry for Elementary Students, A. Browne, C. A. 240
Predicting Performance in Chemistry. Cornog, Jacob and Stoddard, G. D. 701
Preparedness, Chemical Research in National. Faber, H. B. 61
Present Status of the Ionization Theory, The. Kendall, Jas. 374
Prize Essay Contest of 1924–25, The. Howe, H. E. 1099
Prize Essays of the American Chemical Society, Report of the Committee on —1923–1924. Howe, H. E. 3
Problem of High-School Chemistry, A. Clinton, Guy 471
Problem Work in Elementary General Chemistry. Brinkley, S. R. 136
Problems of High-School Chemistry Instruction, The Need for Research on. Glenn, E. R. 670
Problems in Teaching Colloid Chemistry, The Use of. Anderegg, F. O. 780
Profession of Chemistry, Training for the. Crossley, M. L. 667
Proteins from Beef Blood. American Protein Corporation 1150
Pupil Errors in Chemistry, A Study of. Bennett, J. C. 760
Pupils Know of Chemistry When They Begin to Study It, What Do? Rich, Stephen G. 659
Pyrex. Corning Glass Works 1158

Quantitative Problems, A Method for the Calculation of Some. Hopkins, A. J. 344
Questions Relative to the Correlation of

College and High-School Chemistry Courses. Fry, H. S. 260
Rayon—Man-Made Silk. Luft, M. G. 864
Reactions, Museum. Baker, R. A. 480
Records of Students' Work in Chemistry in Greeley High School 1924–25, Summary of. Hannen, F. S. 912
Relation of Chemistry to Agriculture and Forestry, The. Pittman, Oliver C. 17
Relation of Chemistry to Agriculture, The. Jamieson, Ruth. 1111
Relation of Chemistry to the Enrichment of Life, The. Reid, Jas. C. 38
Relation of Chemistry to the Enrichment of Life, The. Singletary, Henry S., Jr. 1106
Relation of Chemistry to the Development of the Industries and Resources of Calif., The. Brownscombe, Eugene. 11
Relation of Chemistry to the Development of the Iron and Steel Industry in the United States, The. Summers, Jane. 1125
Relation of Chemistry to Health and Disease, The. Cordill, Shirley. 1101
Relation of Chemistry to Health and Disease, The. Vivian, Don. L. 32
Relation of Chemistry to the Home, The Nassau, Benj. 22
Relation of Chemistry to the Home, The. Honke, Marion. 1121
Relation of Chemistry to National Defense, The. Allison, Elton R. 27
Relation of Chemistry to National Defense, The. Makepeace. Roger S. 1115
Relationship between High-School and College Chemistry, Report of the Committee on the. 269
Report of Committee of Chemical Education of the A. C. S. Gordon, N. E. 46
Report of the Committee on Prize Essays of the American Chemical Society 1923–1924. Howe, H. E. 3
Report of the Committee on the Relationship between High-School and College Chemistry. 269
Research, Chemical—in National Preparedness. Faber, H. B. 61
Research to Industry, The Application of. Little, A. D. 959
Research on Problems of High-School Chemistry Instruction, The Need for. Glenn, E. R. 670
Research Problems, Chemical. Chapin, W. H. 391
Research Work, Should Teachers Do? Pierce, H. B. 186

Safety First in Storing Chemicals. Davison, H. F. 782
Salt Craving, The Theory of. Harrar, Norman J. 1054
Science, The Appeal of—to the Community. Findlay, Alexander. 852
Science in the High-School, The Teaching of. Spencer, Jessie. 476
Science in Pre-Historic America, Chemistry and. Branegan, J. A. 588
Science Survey, A Texas High-School. Entriken, J. B. and Hodges, F. C. 199
Science Teacher's Opportunity, The. Life, Frank M. 1045
Should Teachers Do Research Work? Pierce, H. B. 186
Soap Industry, The Modern. Preston, Walter C. 1035, 1130
Some Chemical Products of Florida. Beisler, W. H. 437
Some Misconceptions of Chemical Education. Rich, S. G. 142
Some Needed Improvements in Chemistry Texts. Stone, Chas. H. 203
Some Novel Ideas in General Chemistry. Foster, Wm. 289
Some Problems of Curriculum and of Method of Instruction in High-School Chemistry. Powers, S. R. 998
Some Recent Accomplishments of the Chemical Warfare Service. Chemical Warfare Service. 1163
Some Suggested Changes in High-School Chemistry. Browne, Geo. M. 447
Some Suggestions for Modifying the Content of High-School Chemistry to Better Serve the Purposes of a Liberal Education. Osborne, Raymond W. 737
Some Suggestions of the Past Year for Solving the Problems of First-Year Chemistry. Sears, G. W. 146
Some Suggestions as to the Selection of a Laboratory Manual for High-School Chemistry. Bowers, W. G. 605
Standardization of Weights by Richards' Method, The. Semon, W. L. 132
Starting the Small Chemistry Laboratory. Webb, H. A. 353
Storing Chemicals, Safety First in. Davison, H. F. 782
Study of Industrial Chemistry by the Unit Plant Research Development Method. Vilbrandt, Frank C. 748
Study of Pupil Errors in Chemistry, A. Bennett, J. C. 760
Suggestions for Colloid Study. Holmes, H. N. 340
Suggestions to Teachers of Biological Chemistry. I. The Classification of Lipins. Levine, V. E. 181
Suggestions to the Teacher of Chemistry on Poisons and Their Treatment. Turner, R. G. 466
Summary of Records of Students' Work in Chemistry in Greeley High School, 1924–25. Hannen, F. S. 912
Superior Student, Finding and Salvaging the. Hendricks, B. C. 655
Symposium: What Are Our Objectives in Teaching Chemistry?
(1) Wm. C. Morgan 971
(2) J. E. Bell 976
(3) L. F. Foster 977
(4) Alexander Silverman 984
(5) H. I. Schlesinger 987
(6) H. R. Smith 991
(7) Wilhelm Segerblom 994
Synthetic Methanol—An Accomplishment of Chemical Research. DeLong, C. R. 429
Synthetic Organic Chemical Industry in America, The Future of the. Herty, Chas. H. 519
Synthetic Organic Chemicals. Eastman Kodak Co. 1167
System of Laboratory Instruction in Organic Chemistry, A. Howard, J. W. 207

Tanning as a Science. McLaughlin, G. D. and Theis, E. R. 255
Teach Freshman College Chemistry, How We. Hendricks, B. C. 1187
Teaching Atoms and Molecules, A New Method of. Moore, Ed. L. 248
Teaching of Biochemistry, The. Bailey, C. H. 130
Teaching of Biological Chemistry, The. Dutcher, R. A. 127
Teaching Chemistry, Objectives in. Smith, H. R. 585
Teaching Chemistry, Importance of. Munroe, C. E. 67
Teaching, An Experiment in. Stone, Chas. H. 119
Teaching the History of Chemistry, Observations on. Smith, E. F. 533
Teaching Organic Chemistry. Hart, Ed. 109
Teaching Principles of Electrodeposition. Blum, W. 556
Teaching of Science in the High School, The. Spencer, Jessie. 476
Texas High-School Science Survey, A. Entriken, J. B. and Hodges, F. C. 199
Theory of Salt Craving, The. Harrar, Norman J. 1054

Thomas Paine's Theory of Atmospheric Contagion. Browne, C. A. 99
Training for the Profession of Chemistry. Crossley, M. L. 667
Treatment of First-Year Chemistry, Introduction to the Systematic. Glasoe, P. M. 449
True and False Test in Chemistry Teaching, Use of the. Spurgin, W. H. 936
Types of Thought Questions in Chemistry Laboratory Manuals. Cunningham, H. A. 167

Unit Plant Research Development Method, Study of Industrial Chemistry by the. Vilbrandt, Frank C. ... 748
Use of Charts and Graphs in Showing the Growth of Chemical Industries, The. Mattern, L. W. 640
Use of Problems in Teaching Colloid Chemistry, The. Anderegg, F. O. .. 780
Use of the True and the False Test in Chemistry Teaching, The. Spurgin, W. H. 936
Uses of Ethylene. Arentz, F. B. 459
Utilizing Recorded Chemistry. Mellon, M. G. 196

Value of Teaching Valence Prior to Balancing Chemical Equations, The. Zimmerman, J. A. E. 383

Weights, The Standardization of—by Richards' Method. Semon, W. L. .. 132
What the Chemist Does for the Druggist. Burdick, A. S. 677
What Do Pupils Know of Chemistry When They Begin to Study It? Rich, Stephen G. 659

1924 in Retrospect. Killeffer, D. H. 74

Abstracts:

Absorption Spectra and Chemical Constitution. Baly, E. C. C. 1080
Academic Freedom. Anon. 944
Achievement in High-School Chemistry—An Examination of the Subject-Matter. Powers, S. R. 151
Achievement of High-School Students in Chemistry, A Study of the. Rauth, John W. 716
Achievements of Pupils in Chemistry. Rich, S. G. 215
Acid-Resisting Material, A New. West, J. H. 616
Adjusting Marking Systems to Differences in Groups. Tidyman, W. F. 1078
Adsorption of Oxygen by Charcoal, Heat of. Blench, E. A., *et al.* 150
Aid to Tracing Waters Underground, Fluorescein an. Stabber, H. 310
Alchemist, The. Foote, P. D. 385
Alcohol Motor Fuels, The Future of. Whitaker, M. C. 1076
Alfalfa Production, Relation of Sulfur to. Bruce, Oscar C. 942
Allotropy of Zinc. Pierce, W. M., *et al.* .. 1077
Alloy Metals Used in Alloy Steels, Notes on. Vogel, J. L. F. 216
Almighty Atom, The. Roberts, C. E. Bechhofer 938
Alpha Particle, A Proposed Model for the—and Some Nuclear Series. Hargreaves, R. 942
Aluminum, The Electrolytic Refining of. Frary, F. C. 710
Ammonia in Europe, Synthetic versus By-Product. Tupholme, C. H. S. .. 711
Analyzing Cause of Student Failure. Budd, T. A. 941
Anecdotes about Mysterious Explosions and Fires. Gill, Augustus H. 612
Animal Nutrition, The Mineral Elements in. Orr, J. B. 1199
Apparatus in the Class-room, Homemade Models of Technical. Schwantke, C. 411
Application of Science in the Field of Medicine, The Results of the. Johnson, T. A. 507
Applied Chemistry, The Teaching of. Editorial 809
Apprentices, Chemical. Herrmann, G. A. 1203
Approximate Evaluation of Explosion Mixtures, Experiment. Ohmann, O. 307
Art of the Perfumer. Tetlow, Henry 715
Articulation of General Science with the Special Sciences, The. Leker, W. R. 510
Artificial Disintegration of the Elements, The Natural and. Rutherford, Sir E. 149
Artificial Food. Slosson, E. E. 509
Artificial Gasoline. Slosson, E. E. 213
Artificial Gold. Slosson, E. E. 216
Aspects of Practice Teaching in the Preparation of Chemistry Teachers in a State Normal School. Frank, J. O. 616
Association Tendencies and Learning Ability. Cason, H. and Cason, E. B. 813
Astronomy of the Atom, The. Millikan, R. A. 86
Atom, The Almighty. Roberts, C. E. Bechhofer 938
Atom, The Astronomy of the. Millikan, R. A. 86
Atomic Particles, Speeds of. Merrick, A. T. 508
Atomic Weight of Chlorine in Meteorites, The Isotopic Composition and the. Harkins, W. D. and Stone, S. B. 1202
Atom's Amazing Secret of Power Near Solution, The. Seybold, G. B. 809

Bacteriological Chemistry and Industry. MacRae, A. E. 711
Basis of Physical Comfort in Relation to Air Temperature. Hill, E. Vernon .. 938
Benzene, The Discovery of. Tripp, E. N. 814
Benzene, The Discovery of. Thorpe, J. F. 815
Best Courses in Chemical Engineering. Anon. 943
Bibliography of Science Teaching in Secondary Schools. Glenn, Earl R. and Walker, Josephine 1077
Biochemistry, The Philosophical Basis of. Needham, Jos. 716
Boll Weevil Problem, Chemical Warfare and the. Walker, H. W. 412
Bomb-Tubes, Note on the Sealing of Carius. Jacobs, T. R. 612
British Association of Chemists—The Overcrowding of the Profession. H. T. F. R. 714
British Association of Chemists—The Title Chemist. H. T. F. R. 615
Bromine, To Extract—from the Ocean. Staff 716
Business and Chemistry, Partnership of. Teeple, J. E. 413
Business Scavengers. Editorial 1076
Business Value of Chemistry in Education. Malpas, John 807

Carbon Atom in Crystalline Structure, The. Bragg, Sir William 149
Carbon Monoxide, Tests for. Editorial .. 1079
Carius Bomb-Tubes, Note on the Sealing of. Jacobs, T. R. 612
Catalysis, Experiment on. Mannheimer, E. 306
Catalysis and Oxidation. Armstrong, H. E. 1081
Certification of Teachers in Virginia. Sanger, W. T. 305
Chance in Experimenting. Gernsback, H. 508
Character, Effect of Methods of Instruction upon. Fairchild, Milton 615
Character of Laboratory Work for Students of Elementary Chemistry, The. Bowers, W. G. 1201
Character Tests for Pharmacy Entrants. Wulling, F. J. 216

Charcoal, Heat of Adsorption of Oxygen by. Blench, E. A., *et al.* 150
Chemical Apprentices. Herrmann, G. A. 1203
Chemical Constitution, Absorption Spectra and. Baly, E. C. C. 1080
Chemical Education. Smith, H. R. 214
Chemical Engineering. Lewis, W. K. 808
Chemical Engineering, Best Courses in. Anon. 943
Chemical Engineering Aspects of Water Treatment for Railroads. Barr, Wm. M. 810
Chemical Fakes. Felzer, W. R. 414
Chemical Flask Motor, How to Make a. Caley, Earle R. 614
Chemical Laboratory, Grouping Students for Work in the. Bowers, W. G. 306
Chemical Laboratory Study. Long, J. S. 150
Chemical Literature. Howe, H. E. 310
Chemical Quackery. Neville, Harvey A. 709
Chemical Research Laboratory, Design of a. Hollins, Cecil 505
Chemical Research, Universities as Centers of. Editorial 1080
Chemical Revolution, The. Anon. 1076
Chemical Spelling Continued. Jacobson, C. A. 614
Chemical Technology in the Chemistry Course, An Introduction to. Zeitler, H. 306
Chemical Warfare and the Boll Weevil Problem. Walker, H. W. 412
Chemical Warfare Service and Pacifism, The. Noyes, W. A. 712
Chemical Warfare, Relation between Industry and. Beebe, C. H. 216
Chemical Warfare Service, Symposium. Schaar, B. E. 615
Chemicals in Food. Editorial. 1082
Chemist, Complexities of the Industrial. Moore, H. K. 212
Chemist, I Am a. Bellis, Berton 712
Chemist, The Title—British Assn. of Chemists. H. T. F. R. 615
Chemist, Training the—A Critical Survey. Noyes, W. A., Jr. 308
Chemists in the University of Minnesota, The Training of. Pervier, N. C. 308
Chemistry, Achievement in High-School. Powers, S. R. 151
Chemistry, Achievements of Pupils in. Rich, S. G. 215
Chemistry in America, Fifty Years of. Nichols, W. H. 87
Chemistry Books for the High-School Library. Walton, J. H. 411
Chemistry Course, An Introduction to Chemical Technology in the. Zeitler, H. 306
Chemistry, The Discipline of. Desch, C. H. 1200
Chemistry in Education, The Business Value of. Malpas, John 807
Chemistry, Geology and. Vieweg, H. 414
Chemistry in High-School Training, The Necessity of. Amick, C. A. 409
Chemistry in and about the Home. Stroup, F. P. 1202
Chemistry, Partnership of Business and. Teeple, J. E. 413
Chemistry and Peace. Haldane, J. B. S. 150
Chemistry and the Periodic System, High-School. Glasoe, P. M. 85
Chemistry, Measurement of the Results of the Teaching of. Gerry, Henry L. 89
Chemistry of Microbes, Pioneering in the. Kendall, A. T. 507
Chemistry, The Need and Use of a Scientific Measure of the Results of the Teaching of. Gerry, H. L. 216
Chemistry and Sanitation at Mass. Homeopathic Med. Soc. Prescott, S. C. 944
Chemistry of Sewage Treatment. Buswell, A. M. 713
Chemistry, Social Values of High-School. Kelsey, T. D. 411
Chemistry Teachers, Aspects of Practice Teaching in the Preparation of—in a State Normal School. Frank, J. O. .. 616
Chemistry Teachers, Prospective and in Service, The Training of. Hopkins, B. S. 309
Chemistry in War: An 18th Century Viewpoint. Davis, Tenney L. 1082
Chinese Camphor and Camphor Oil. Bryant, P. L. 805
Chlorine for Colds. Kremers, H. C. 305
Chlorine Gas, Electric Production of. Anderson, Carl W. 715
Chlorine in Meteorites, The Isotopic Composition and the Atomic Weight of. Harkins, W. D. and S. B. Stone 1202
Classification and Eligibility. Redman, S. L. 614
Class-room, Home-made Models of Technical Apparatus in the. Schwantke, C. 411
Clearing House for High-School Information, A. Editorial 716
Coal, The Coking and Swelling Constituents of. Fischer, Franz 710
Coal Dust Explosions, Stop. Andrews, J. B. 714
Coking and Swelling Constituents of Coal, The. Fischer, Franz 710
Colds, Chlorine for. Kremers, H. C. 305
College Class-room, Playing the Game in the. Higbee, H. H. 509
College Course, A New Type of. Miner, J. B. 1076
College Curricula and Social Institutions. Taylor, Howard 807
College Placement Examinations. Seashore, C. E. 88
College Qualifying Examinations. Ruch, G. M. 709
Compleat Chemyst, The Making of a. Armstrong, Henry E. 87
Complexities of the Industrial Chemist. Moore, H. K. 212
Concepts, Fundamental. Heyl, Paul R. 312
Constitution of the Earth, Metal Resources and the. T. C. 814
Correcting Examination Papers. Breeze, Retha E. 150
Correlation of Pharmaceutical and Medical Education, The. Rusby, H. H. 812
Course in General Science, A Ninth Grade. Owens, K., *et al.* 613
Course of Study, The Tyranny of a Standardized. Jordan, C. J. 415
Crodon. Editorial 811
Crystal Analysis as an Auxiliary in Organic Chemical Research, X-ray. Robinson, R. 938
Crystalline Structure, The Carbon Atom in. Bragg, Sir William 149
Crystalline Structure of Inorganic Salts, The. Bragg, W. L. 1080
Crystals, Inorganic. Bragg, W. L. 710
Cultural Aspects in Geology. Parks, W. A. 1202
C. W. S., Technical Developments of the —since the War. Gorin, F. B. 218

Democracy, Science Teaching in a. Slosson, E. E. 87
Design of a Chemical Research Laboratory. Hollins, Cecil 505
Developments of the C. W. S. since the War, Technical. Gorin, F. B. 218
Developments in the Nitrogen Problem, Trend of. Braham, J. M. 88
Discharge of Electricity through Vacuum Tubes. Whiddington, R. 1200
Discipline of Chemistry, The. Desch, C. H. 1200
Discovery of Benzene, The. Thorpe, J. F. 815
Discovery of Benzene, The. Tripp, E. N. 814
Disintegration of the Elements, The Natural and Artificial. Rutherford, Sir E. 149
Doctor Sunshine. Harrow, Benj 811

Education, Chemical. Smith, H. R..... 214
Education in China, Status of Science. Twiss, G. R..... 215
Education, The Elimination of Waste in. Caldwell, O. W..... 214
Education, H. G. Wells on. Davis, Ada E..... 1204
Education, Individuality and Uniformity in. McConaughy, J. L..... 806
Education, The Inquiring Mind in Gamble, G. C..... 416
Education and Legislation. Beard, J. G. 307
Education and Legislation, Report of the Section of A. Ph. A. Mansfield, W. 413
Education, The Place of Religion in Higher. Richmond, C. A..... 509
Education for Profit. Rudd, W. F..... 1202
Education, Public—in Poland. Mazurowska, M..... 87
Educational Value of Nature Study. Riley, C. F. Curtis..... 709
Educational Values in Laboratory Work, Some. Powers, W. G..... 149
Effect of Methods of Instruction upon Character. Fairchild, Milton..... 614
Efficiency, Resectioning Students According to. Shapiro, A. A..... 416
Egypt, the Land of the Alchemists. Hopkins, A. J..... 1079
Electric Light Bulb in General Science, The Possibilities of a "Burned Out." Obourn, E. S..... 613
Electric Production of Chlorine Gas. Anderson, Carl W..... 715
Electricity through Vacuum Tubes, The Discharge of. Whiddington, R..... 1200
Electrolytic Refining of Aluminum, The. Frary, F. C..... 710
Electron Constraint in Ions and Molecules, Refractions and. Smyth, Chas. P. 942
Electron and Light Quanta, The—What Are They? Millikan, R. A..... 151
Elementary Students, Teaching Temperature Effects to. Baker, R. A..... 616
Elements of Glass Blowing and Demonstrations. Johnson, W. C..... 507
Elements, The Natural and Artificial Disintegration of the. Rutherford, Sir E..... 149
Elements, Some Recent Representations of the Periodicity of the. Druce, J. G. F..... 612
Eligibility, Classification and. Redman, S. L..... 614
Elimination of Waste in Education, The. Caldwell, O. W..... 214
Engineering, Chemical. Lewis, W. K.... 808
Engineers and Their Power Plants, Two. Moore, R. C..... 1200
Ethics and the Test Tube. Seaverns, J. A. 412
Ethyl Gasoline, Exhaust Gases from Engines Using. Fielder, A. C., *et al*..... 213
Evaluation of Objectives in Chemistry by Teachers in Cleveland, etc., Report on. Salter, C. H..... 505
Examination, Making the Regents'. Burdge, Howard G..... 415
Examination Papers, Correcting. Breeze, Retha E..... 150
Examinations, College Placement. Seashore, C. E..... 88
Examinations, College Qualifying. Ruch, G. M..... 709
Exhaust Gases from Engines Using Ethyl Gasoline. Fielder, A. C., *et al*..... 213
Experiment: The Approximate Evaluation of Explosion Mixtures. Ohmann, O..... 307
Experiment on Catalysis. Mannheimer, E. 306
Experimenting, Chance in. Gernsback, H..... 508
Experiments with Explosive Gas Mixtures. Ohmann, O..... 506
Explosions and Fires, Anecdotes about Mysterious. Gill, A. H..... 612
Explosions, Stop Coal Dust. Andrews, J. B..... 714
Explosive Gas Mixtures, Experiments with. Ohmann, O..... 506
Explosive Mixtures, The Approximate Evaluation of: Experiment. Ohmann, O..... 307

Fakes, Chemical. Felzer, W. R..... 414
Faraday Benzene Centenary, The. Armstrong, H. E..... 815
Faraday Benzene Centenary and Kekulé, The. Borns, H..... 939
Faraday as a Chemist. Pope, W. J..... 815
Faraday and His Contemporaries. Cohen, Ernst..... 815
Field of Medicine, The Results of the Application of Science in the. Johnson, T. A..... 507
Fifty Years of Chemistry in America. Nichols, W. H..... 87
Fires, Anecdotes about Mysterious Explosions and. Gill, A. H..... 612
Fluorescein an Aid to Tracing Waters Underground. Stabber, H..... 310
Food, Artificial. Slosson, E. E..... 509
Food, Chemicals in. Editorial..... 1082
Food, Instinct as a Guide to. Harrow, B., *et al*..... 715
Footlight Dimmer, An Inexpensive. Whitman, W. G..... 805
Foreign Language Study, Modern. Doyle, H. G..... 1076
Frozen-In Glass Stopcocks and Stoppers, Simple Methods for Removing. Ardagh, E. G. R..... 711
Fundamental Concepts. Heyl, Paul R. 312
Fused Silica. Thomson, Elihu..... 1081
Future of Alcohol Motor Fuels, The. Whitaker, M. C..... 1076
Future Science of the Schools, The. Armstrong, H. E..... 940
Future Science of the Schools, The. (reply) (1) C. L. Bryant, (2) J. A. Nairn, (3) W. H. D. Rouse, (4) H. A. Wooton, (5) W. H. F., (6) H. E. Armstrong (7) W. M. Heller..... 1081 1201

Gas Generator, U-Tube. Oldroyd, C. A. 715
Gas Mixtures, Experiments with Explosive. Ohmann, O..... 506
Gasoline, Artificial. Slosson, E. E..... 213
General Science, The Articulation of—with the Special Sciences. Leker, W. R... 510
General Science, A Ninth Grade Course in. Owens, K., *et al*..... 613
General Science, Use of Text-Book and Syllabus Courses in. Curtis, Francis D..... 613
Geology and Chemistry. Vieweg, H..... 414
Geology, Cultural Aspects in. Parks, W. A..... 1202
Germicides, New. Slosson, E. E..... 305
Glass Blowing and Demonstrations, Elements of, Johnson, W. C..... 507
Glue Factory, June Visits a. Ahlers, Lena C..... 1200
Gold, Artificial. Slosson, E. E..... 216
Grading System, Uniform. Rogers, Jas. H..... 1078
Graduate Schools of America, The. Hughes, R. M..... 712
Grouping Students for Work in the Chemical Laboratory. Bowers, W. G..... 306

Handmaids of Medicine, The. Baker, L. H..... 1083
Heat of Adsorption of Oxygen by Charcoal. Blench, E. A., *et al*..... 150
H. G. Wells on Education. Davis, Ada E. 1204
High-School, The. Editorial..... 806
High-School Chemistry, Achievement in. Powers, S. R..... 151
High-School Chemistry, How Can We Humanize? Fiedler, Alban..... 713

High-School Chemistry and the Periodic System. Glasoe, P. M. 85
High-School Chemistry, Social Values of. Kelsey, T. D. 411
High-School Library, Chemistry Books for the. Walton, J. H. 411
High-School Science Teachers, A Study of Their Training in Relation to the Subjects They Are Teaching. Hutson, P. W. 85
High-School Science Text-books, The Vocabularies of. Powers, S. R. 215
High-School Training, The Necessity of Chemistry in. Amick, C. A. 409
High Schools, Opportunities for Science Teachers in New York. Benedict, R. A. 86
Historical Method in School Science Courses. Holmyard, E. J. 941
Historic Set of Weights. Fonda, J. S. 308
Histrionic Nature of Teaching, The. Steppat, Margaret. 812
Home-made Models of Technical Apparatus in the Class-room. Schwantke, C. 411
How Can We Humanize High-School Chemistry? Fiedler, Alban 713
How to Make a Chemical Flask Motor. Caley, Earle R. 614
Humanism in Science Teaching. Marvin, F. S. 941
Hydrogen Sulfide, To Conserve. Herrmann, Geo. A. 1083
Hydrogen Sulfide Gas; a Convenient Method for the Generation of Same. Field, E., *et al.* 505

I Am a Chemist. Bellis, Berton 712
Ideal Professor, The Rhodes Scholar's. Brooks, Wendell S. 712
Impregnating Timber with Zinc Chloride and Petroleum Oils, One-Movement Process for. Howald, A. M. 613
Individuality and Uniformity in Education. McConaughy, J. L. 806
Industrial Chemist, Complexities of the. Moore, H. K. 212
Industrial Chemistry at Wembley. Editorial 940
Industrial Necessity, Sulfur an. Lint, N. C. 414
Industrial Poisons. Henderson, E. V. 309
Industrial Research, Value of. U. S. Bureau of Standards Visiting Committee 808
Industry, Bacteriological Chemistry and. MacRae, A. E. 711
Industry and Chemical Warfare, Relation between. Beebe, C. H. 216
Industry, Science and. Fischer, Martin H. 154
Inexpensive Footlight Dimmer, An. Whitman, W. G. 805
Information, A Clearing House for High-School. Editorial 716
Inoculation, The Study of the Influence of—upon the Fermentation of Sauerkraut. Brunkow, O. R., *et al.* 942
Inorganic Crystals. Bragg, W. L. 710
Inorganic Salts, The Crystalline Structure of. Bragg, W. L. 1080
Inquiring Mind in Education, The. Gamble, G. C. 416
Instinct as a Guide to Food. Harrow, B., *et al.* 715
Instruction, Effects of Methods of—upon Character. Fairchild, Milton. 614
Intelligence, Teachers' Marks and. Unzicker, S. 416
International Education Research Council and World Bureau of Education. Luckey, G. W. A. 1078
Inter-relation of the Sciences, The. Salzberg, Paul L. 713
International Research Council, The. Editorial 940
Interviewing the Stars. Showalter, W. J. 151
Introduction to Chemical Technology in the Chemistry Course. Zeitler, H. ... 306
Isotopes of Mercury, The. Aston, F. W. 1080
Isotopic Composition and the Atomic Weight of Chlorine in Meteorites, The. Harkins, W. D. and Stone, S. B. 1202
Is the Project Method a Contribution? Roark, M. L. 416
Is This a Cure for Tuberculosis? Emerson, Haven 714

Jacques Loeb. DeKruif, Paul 806
June Visits a Glue Factory. Ahlers, Lena C. 1200

Kekulé, The Faraday Benzene Centenary and. Borns, H. 939

Laboratory the Basis of High-School Science, Making the. Radcliffe, H. H. 1201
Laboratory Study, Chemical. Long, J. S. 150
Laboratory Work, Some Educational Values in. Powers, W. G. 149
Laboratory Work for Students of Elementary Chemistry, The Character of. Bowers, W. G. 1201
Learning Ability, Association Tendencies and. Cason, H. and Cason, E. B. ... 813
Lecture Method, The. Smith, H. R. 1203
Legislation, Education and. Beard, J. G. 307
Leonardo da Vinci, The Physical Science of: A Survey. Hart, Ivor B. 942
Liberal Arts College, A Standard. Snavely, Guy E. 709
Library, Chemistry Books for the High-School. Walton, J. H. 411
Life, Making Science Teaching More Effective in Relationship to. Hollister, H. A. 713
Light Quanta, The Electron and—What Are They? Millikan, R. A. 151
Limitations of Training, The Possibilities and. Terman, L. M. 149
Liquid Air Plant at the University of Kansas. Cady, H. P. 213
Literature, Chemical. Howe, H. E. 310
Lubricant, Stop-Cock Lubrication and an Improved. Ardagh, E. G. R. 712

Magnetite, The Transformation of—into Hematite. Wels, Lars A. and Baudisch, Oskar 943
Making of a Compleat Chemyst, The. Armstrong, Henry E. 87
Making the Laboratory the Basis of High-School Science. Radcliffe, H. H. 1201
Making the Regents' Examination. Burdge, Howard G. 415
Making Science Teaching More Effective in Relation to Life. Hollister, H. A. 713
Making of Soap, The. Ahlers, Lena C. .. 1200
Man Who Soothed the Brow of Agony, The. Rackemann, F. M., *et al.* 712
Manganese Group, Two New Elements of the. Editorial 939
Manufacture of Tinsel, The. Proctor, C. H. 412
Marking Systems, Adjusting—to Differences in Groups. Tidyman, W. F. .. 1078
Material, A New Acid-Resisting. West, J. H. 616
Meaning of Scientific Research, The. Pupin, M. I. 217
Measure of the Results of the Teaching of Chemistry, The Need and Use of a Scientific. Gerry, H. L. 216
Measurements of the Results of the Teaching of Chemistry. Gerry, Henry L. 89
Medicine, The Handmaids of. Baker, L. H. 1083
Mercury into Gold, Transformation of. Russell, A. S. 1081

Mercury Halide: A Correction. Manley, J. J. ... 814
Mercury, The Isotopes of. Aston, F. W. 1080
Mercury-Vapor Trap, Potassium as a. Poindexter, F. E. and Hughes, A. L. .. 942
Metal Resources and the Constitution of the Earth. T. C. ... 814
Metallography as a Study for Chemists. Mason, C. W. ... 414
Metals, The Periodic Sphere and the Position of the Rare Earth. Friend, J. Newton ... 409
Meteorites, The Isotopic Composition and the Atomic Weight of Chlorine in. Harkins, W. D. and Stone, S. B. 1202
Methods of Instruction, Effect of—upon Character. Fairchild, Milton ... 614
Metric System in Schools. Harrigan, M. H. ... 808
Microbes, Pioneering in the Chemistry of. Kendall, A. T. ... 507
Mineral Elements in Animal Nutrition, The. Orr, J. B. ... 1199
Modern Foreign Language Study. Doyle, H. G. ... 1076
Modern Trend in the Science of Ventilation. West, P. ... 153
Mosely's Work on X-Rays. Rutherford, Sir Ernest ... 1081

Natural and Artificial Disintegration of the Elements, The. Rutherford, Sir Ernest ... 149
Natural Science by the Experimental Method. Woodhull, John F. ... 805
Natural Science, Supervised Study in. Pieper, C. J. ... 86
Nature Study, Educational Value of. Riley, C. F. Curtis ... 709
Nature and Ultranature. Turner, J. E. .. 1204
Necessity of Chemistry in High-School Training, The. Amick, C. A. ... 409
Need for Teachers. Cooper, Z. M. ... 307
Need and Use of a Scientific Measure of the Results of the Teaching of Chemistry. Gerry, H. L. ... 216
New Acid-Resisting Material, A. West, J. H. ... 616
New Germicides. Slosson, E. E. ... 305
New Method of Zinc Coating Wire, A. Schueler, J. L. ... 1203
New and Rapid Method for the Removal of Phosphates in Systematic Qualitative Analysis. Curtman, L. J., *et al.* 807
New Type of College Course, A. Miner, J. B. ... 1076
Ninth Grade Course in General Science, A. Owens, K., *et al.* ... 613
Nitrogen Problem, Trend of Developments in. Braham, J. M. ... 88
Nitrogen, The Ups and Downs of. Griffith, I. ... 1202
Note on the Sealing of Carius Bomb-tubes. Jacobs, Thos. R. ... 612
Notes on Alloy Metals Used in Alloy Steels. Vogel, J. L. F. ... 216

Obesity, An Outline of. Neville, Harvey A. ... 713
Obituary of Sir Edward Thorpe. Tutton, A. E. N. ... 411
Objectives in Chemistry by Teachers in Cleveland, etc., Report on Evaluation of. Salter, C. H. ... 505
One-Movement Process for Impregnating Timber with Zinc Chloride and Petroleum Oils. Howald, A. M. ... 613
Oneness of the Universe, The. Fussler, Karl ... 812
Opportunities for Science Teachers in New York High Schools. Benedict, R. A. ... 86
Outline of Obesity, An. Neville, Harvey A. ... 713
Overcrowding of the Profession, The—British Assoc. of Chemists, H. T. F. R. 714
Overlapping in High School and College. Koos, Leonard V. ... 714
Ox Cart or Auto—Which? Hill, E. Vernon ... 938
Oxidation, Catalysis and. Armstrong, H. E. ... 1081
Oxygen, Heat of Adsorption of—by Charcoal. Blench, E. A., *et al.* ... 150

Pacifism, The Chemical Warfare Service and. Noyes, W. A. ... 712
Partnership of Business and Chemistry. Teeple, J. E. ... 413
Pasteur. Kuebler, John, R. ... 510
Peace, Chemistry and. Haldane, J. B. S. 150
Pension System for M. I. T. Anon ... 943
Perfumer, Art of the. Tetlow, Henry 715
Periodic Sphere and the Position of the Rare Earth Metals, The. Friend, J. Newton ... 409
Periodic System, High-School Chemistry and the. Glasoe, P. M. ... 85
Periodicity of the Elements, Some Recent Representations of the. Druce, J. G. F. ... 612
Personal Element in Teachers' Marks, The. Hulton, C. E. ... 941
Petroleum Industry, Research Problems Presented by the. Hill, J. B. ... 617
Petroleum Oils, One-Movement Process for Impregnating Timber with Zinc Chloride and. Howald, A. M. ... 613
Pharmaceutical and Medical Education, The Correlation of. Rusby, H. H. .. 812
Pharmacy Entrants, Character Tests for. Wulling, F. J. ... 216
Pharmacy Teacher Training. Wulling, F. J. ... 1202
Pharmacy, Three-Year Course in. Lyman, R. A. ... 812
Philosophical Basis of Biochemistry, The. Needham, Jos. ... 716
Phosphates in Systematic Qualitative Analysis, New and Rapid Method for the Removal of. Curtman, L. J., *et al.* 807
Photochemistry, Recent Developments in. Noyes, W. A. ... 714
Photograph in Judging Human Character, Value of the. Patterson, D. G. ... 1203
Photography, Significant Progress in Research in. Mees, C. E. K. ... 806
Photosynthesis. Baly, E. C. C. ... 85
Photosynthesis of Naturally Occurring Compounds. Baly, E. C. C. ... 1199
Physical and Biological Science at Wembley. Anon ... 813
Physical Comfort in Relation to Air Temperature, Basis of. Hill, E. Vernon .. 938
Physical Science of Leonardo da Vinci, The: A Survey. Hart, Ivor B. ... 942
Pioneering in the Chemistry of Microbes. Kendall, A. T. ... 507
Place of Religion in Higher Education, The. Richmond, C. A. ... 509
Place of Science in the Secondary School, The. Hunter, G. W. ... 709
Placement Examinations, College. Seashore, C. E. ... 88
Playing the Game in the College Classroom. Higbee, H. H. ... 509
Poisons, Industrial. Henderson, E. V. ... 309
Popular Prejudice, When the Scientific Mind Meets. Stark, W. E. ... 416
Position of the Rare Earth Metals, The Periodic Sphere and the. Friend, J. Newton ... 409
Possibilities of a "Burned Out" Electric Light Bulb in General Science. Obourn, E. S. ... 613
Possibilities and Limitations of Training, The. Terman, L. M. ... 149
Potassium as a Mercury-Vapor Trap. Poindexter, F. E. and A. L. Hughes .. 942
Practical Teachers, A Rating Scale for. Kinder, J. S. ... 1204

Practice Teaching, Aspects of—in the Preparation of Chemistry Teachers in a State Normal School. Frank, J. O. 616
Preliminary Note on the Transmutation of Mercury into Gold. Nagaoka, H. 939
Preparing for College, Some Essentials in the Process of. Randall, Otis E. 1078
Project Method, Is the—a Contribution, Roark, M. L. 416
Proposed Model for the Alpha Particle and Some Nuclear Series, A. Hargreaves, R. 942
Public Education in Poland. Mazurowska, M. 87
Public School Teacher as a Research Worker, The. Buckingham, B. R. 713
Pupils in Chemistry, Achievements of. Rich, S. G. 215
Pure Research and Practical Research. Charters, W. W. 1200

Rare Earth Metals, The Periodic Sphere and the Position of the. Friend, J. Newton 409
Rating Scale for Practical Teachers, A. Kinder, J. S. 1204
Reaction and Reactivity. Baly, E. C. C. 944
Recent Developments in Photo-Chemistry. Noyes, W. A. 714
Refined Sulfurs: Their Manufacture and Uses. Newhall, C. A. 810
Refractions and Electron Constraint in Ions and Molecules. Smyth, Chas. P. 942
Regents' Examination, Making the. Burdge, Howard G. 415
Relation between Industry and Chemical Warfare. Beebe, C. H. 216
Relation of Sulfur to Alfalfa Production, Bruce, Oscar C. 942
Religion in Higher Education, The Place of. Richmond, C. A. 509
Report on Chemistry. Salter, C. H. 812
Report on Evaluation of Objectives in Chemistry by Teachers in Cleveland, Ohio, Schools and Information Test for Pupils. Salter, C. H. 505
Report of the Section of Education and Legislation, A. Ph. A. Mansfield, W. 413
Research and Practical Research, Pure. Charters, W. W. 1200
Research, The Meaning of Scientific. Pupin, M. I. 217
Research Laboratory, Design of a Chemical. Hollins, Cecil. 505
Research Problems Presented by the Petroleum Industry. Hill, J. B. 617
Research Worker, The Public School Teacher as a. Buckingham, B. R. 713
Resectioning Students According to Efficiency. Shapiro, A. A. 416
Results of the Application of Science in the Field of Medicine, The. Johnson, T. A. 507
Results of the Teaching of Chemistry, The Need and Use of a Scientific Measure of the. Gerry, H. L. 216
Rhodes Scholar's Ideal Professor, The. Brooks, Wendell S. 712
Russian Academy of Sciences, The. Editorial 1202

Sanitation at Mass. Homeopathic Med. Soc., Chemistry and. Prescott, S. C. 944
Sealing of Carius Bomb-Tubes, Note on the. Jacobs, Thos. R. 612
Service the Needed Spirit of Modern Science Instruction. Caldwell, O. W. 310
Sewage Treatment, Chemistry of. Buswell, A. M. 713
School Science Courses, Historical Method in. Holmyard, E. J. 941
Science in the Field of Medicine, The Results of the Application of. Johnson, T. A. 507
Science and Industry. Fischer, Martin H. 154
Science in the Secondary School, The Place of. Hunter, G. W. 709
Science of the Schools, The Future. Armstrong, H. E. 940
Science, The Spirit of. Editorial 938
Science, Teaching a New. Berg, E. 212
Science of Ventilation, Modern Trend in the, West, P. 153
Science Education in China, Status of, Twiss, G. R. 215
Science Teachers, High-School. Hutson, P. W. 85
Science Teachers, Opportunities for—in New York High Schools. Benedict, R. A. 86
Science Teaching in a Democracy. Slosson, E. E. 87
Science Teaching More Effective in Relation to Life, Making. Hollister, H. A. 713
Science Teaching in Secondary Schools, Bibliography of. Glenn, Earl R., and Walker, Josephine 1077
Science Teaching, Thoroughness in, Pickles, A. 151
Sciences, The Inter-relation of the. Salzberg, Paul L. 713
Scientific Measure of the Results of the Teaching of Chemistry, The Need and Use of a. Gerry, H. L. 216
Scientific Method, The. Editorial 1076
Scientific Mind Meets Popular Prejudice, When the. Stark, W. E. 416
Scientific Research, The Meaning of. Pupin, M. I. 217
Significance of Dayton, The. Schaar, B. E. 1077
Significant Progress in Research in Photography. Mees, C. E. K. 806
Silica, Fused. Thomson, Elihu 1081
Silver, Stainless. Staff 714
Simple Methods for Removing Frozen-In Glass Stopcocks and Stoppers. Ardagh, E. G. R. 711
Soap, The Making of. Ahlers, Lena C. 1200
Social Institutions, College Curricula and. Taylor, Howard 807
Social Values of High-School Chemistry. Kelsey, T. D. 411
Some Essentials in the Process of Preparing for College. Randall, Otis E. 1078
Some Recent Representations of the Periodicity of the Elements. Druce, J. G. F. 612
Special Sciences, The Articulation of General Science with the. Leker, W. R. 510
Speeds of Atomic Particles. Merrick, A. T. 508
Spelling Continued, Chemical. Jacobson, C. A. 614
Spirit of Science, The. Editorial 938
Stainless Silver. Staff 714
Standard Liberal Arts College, A. Snavely, Guy E. 709
Standardized Course of Study, The Tyranny of a. Jordan, C. J. 415
Stars, Interviewing the. Showalter, W. J. 151
Status of Science Education in China. Twiss, G. R. 215
Steels, Notes on Alloy Metals Used in Alloy. Vogel, J. L. F. 216
Stop Coal Dust Explosions. Andrews, J. B. 714
Stop-Cock Lubrication and an Improved Lubricant. Ardagh, E. G. R., *et al.* 712
Student Failure, Analyzing Cause of. Budd, T. A. 941
Students According to Efficiency, Resectioning. Shapiro, A. A. 416
Students of Elementary Chemistry, The Character of Laboratory Work for. Bowers, W. G. 1201
Students, Grouping—for Work in the Chemical Laboratory. Bowers, W. G. 306

Study of the Achievement of High-School Students in Chemistry, A. Rauth, John W. 716
Study, Chemical Laboratory. Long, J. S. 150
Study for Chemists, Metallography as a. Mason, C. W. 414
Study of the Influence of Inoculation upon the Fermentation of Sauerkraut, The. Brunkow, O. R., *et al* 942
Study in Natural Science, Supervised. Pieper, C. J. 86
Sulfur. Wolf, A. G. 151
Sulfur, an Industrial Necessity. Lint, H. C. 414
Sulfur, Relation of—to Alfalfa Production. Bruce, Oscar, C. 942
Superior Student in College, The. Thwing, Chas. F. 1079
Supervised Study in Natural Science. Pieper, C. J. 86
Syllabus Courses in General Science, Use of Text-Book and. Curtis, Francis D. 613
Symposium Chemical Warfare Service. Schaar, B. E. 615
Synthetic versus By-Product Ammonia in Europe. Tupholme, C. H. S. 711

Teacher as a Research Worker, The Public School. Buckingham, B. R. 713
Teacher Training, Pharmacy. Wulling, F. J. 1202
Teachers, High-School Science. Hutson, P. W. 85
Teachers', Marks and Intelligence. Unzicker, S. 416
Teachers' Marks, The Personal Element in. Hulton, C. E. 941
Teachers, Need for. Cooper, Z. M. 307
Teachers, The Training of. Malim, F. B. 1201
Teachers in Virginia, Certification of. Sanger, W. T. 305
Teaching of Applied Chemistry, The. Editorial 809
Teaching Chemistry to Beginners along Historical Lines. Stern, R. 941
Teaching of Chemistry, Measurements of the Results of the. Gerry, Henry L. 89
Teaching of Chemistry, The Need and Use of a Scientific Measure of the Results of the. Gerry, H. L. 216
Teaching in a Democracy, Science. Slosson, E. E. 87
Teaching, The Histrionic Nature of. Steppat, Margaret 812
Teaching—A New Science. Berg, E. 212
Teaching Temperature Effects to Elementary Students. Baker, R. A. 616
Teaching, Thoroughness in Science. Pickles, A. 151
Technical Apparatus in the Class-room, Home-made Models of. Schwantke, C. 414
Technical Developments of the C. W. S. since the War. Gorin, F. B. 218
Technical Libraries. Editorial 809
Technology in the Chemical Course, An Introduction to Chemical. Zeitler, H. 306
Temperature Effects, Teaching—to Elementary Students. Baker, R. A. 616
Tenth Revision of the U. S. Pharmacopoeia, The. Whelpley, J. M. 710
Tests for Carbon Monoxide. Editorial 1079
Test Tube, Ethics and the. Seaverns, J. A. 412
Text-Book and Syllabus Courses in General Science, Use of. Curtis, Francis D. 613
Thoroughness in Science Teaching. Pickles, A. 151
Thorpe, Obituary of Sir Edward. Tutton, A. E. H. 411
Three-Year Course, The. Cooper, Zada M. 710
Three-Year Course in Pharmacy. Lyman, R. A. 812
Tinsel, The Manufacture of. Proctor, C. H. 412
Tissue Transplantation, Nakahara, W. 806
Title Chemist, The—The British Assn. of Chemists. H. T. F. R. 615
To Conserve Hydrogen Sulfide. Herrmann, Geo. A. 1083
To Extract Bromine from the Ocean. Staff 716
Tracing Waters Underground, Fluorescein, an Aid to. Stabber, H. 310
Training the Chemist—A Critical Survey. Noyes, W. A., Jr. 308
Training of Chemists in the University of Minnesota, The. Pervier, N. C. 308
Training of Chemistry Teachers, Prospective and in Service, The. Hopkins, B. S. 309
Training, The Possibilities and Limitations of. Terman, L. M. 149
Training of Teachers, The. Malim, F. B. 1201
Transformation of Magnetite into Hematite, The Two-Stage. Wels, Lars A. and Baudisch, Oskar 943
Transformation of Mercury into Gold. Russell, A. S. 1081
Transmutation of Mercury into Gold, Preliminary Note on. Nagaoka, H. 939
Transmutation of Uranium into Uranium-X, The. Gaschler, A. 1202
Trend of Developments in the Nitrogen Problem. Braham, J. M. 88
Tuberculosis, Is This a Cure for? Emerson, Haven 714
Twilight Zone of Matter, The. Findlay, Alexander 1082
Two Engineers and Their Power Plants. Moore, R. C. 1200
Two New Elements of the Manganese Group. Editorial 939
Two-Stage Transformation of Magnetite into Hematite, The. Wels, Lars A. and Baudisch, Oskar 943
Tyranny of a Standardized Course of Study. Jordan, C. J. 415

Ultranature, Nature and. Turner, J. E. 1204
Uniform Grading System. Rogers, Jas. H. 1078
Universities as Centers of Chemical Research. Editorial 1080
University of London's New M.Sc. Degree. Hart, I. B. 214
Ups and Downs of Nitrogen, The. Griffith, I. 1202
Uranium into Uranium-X, The Transmutation of. Gaschler, A. 1202
U. S. Pharmacopoeia, The Tenth Revision of the. Whelpley, J. M. 710
Use of a Scientific Measure of the Results of the Teaching of Chemistry, The Need and. Gerry, H. L. 216
Use of Text-Book and Syllabus Courses in General Science. Curtis, Francis D. 613
U-Tube Gas Generator. Oldroyd, C. A. 715

Vacuum Tubes, The Discharge of Electricity through. Whiddington, R. 1200
Value of Industrial Research. U. S. Bureau of Standards Visiting Committee 808
Value of the Photograph in Judging Human Character. Patterson, D. G. 1203
Values of High-School Chemistry, Social. Kelsey, T. D. 411
Vanadium—A Curiosity among Minerals. Staff 715
Ventilation, Modern Trend in the Science of. West, P. 153
Vocabularies of High-School Science Textbooks. Powers, S. R. 215
Vocational Guidance Needed in Universities. Elliff, J. D. 941

Waimangu and the Hot-Spring Country of New Zealand. Grew, Jos. C. 811
Warp and Woof in Education. Vaughan, W. W. 1079
War Paint. Tetlow, H. 807
Waste in Education, The Elimination of. Caldwell, O. W. 214
Water Treatment for Railroads, Chemical Engineering Aspects of. Barr, Wm. M. 810
Waters Underground, Fluorescein an Aid to Tracing. Stabber, H. 310
Way of the Wind, The. Humphreys, W. J. 1078
Weights, Historic Set of. Fonda, J. S. ... 308
When the Scientific Mind Meets Popular Prejudice. Stark, W. E. 416
Why High-School Pupils Fail. Edmondson, J. D. 941
Wind, The Way of the. Humphreys, W. J. 1078

X-Ray Crystal Analysis as an Auxiliary in Organic Chemical Research. Robinson, R. 938
X-Rays, Mosely's Work on. Rutherford, Sir Ernest 1081

Zinc, Allotropy of. Pierce, W. M., *et al.* 1077
Zinc Chloride and Petroleum Oils, One-Movement Process for Impregnating Timber with. Howald, A. M. 613
Zinc Coating Wire, A New Method of. Schueler, J. L. 1203

Digests:

Does Education Make the Man? 1072
Educational Weaving 1070
Overlapping of High-School and College Chemistry—An Abstract 798
Proper Training for Graduate Students Preparing for Professorships in the Smaller Colleges, The 1197
Quo Vadis? 1073
Subsidizing Accomplishment 804
Synthetic Products 802

Correspondence:

"Chemistry as Depicted in Art." Gill, A. H. 1192
Convenient Suction Pump, A. Mock, F. Earle 1064
Educating the Public in Weights and Measures. Dale, Samuel S. 1064
"Mournful Numbers." Carpenter, H. A. 1063
Promoting the Essay Contest. Miller, L. Paul 1067

Book Reviews:

Applied Chemistry. A Laboratory Manual, by Emery, Miller, and Boynton .. 1088
Biology and Human Welfare, by J. E. Peabody, *et al.* 621
Chart Showing the Chemical Relationships in the Mineral Kingdom, by P. C. Putnam 623
Chemical Encyclopaedia, by C. T. Kingzett 514
Chemistry of Engineering Materials, by Robt. B. Leighou 818
Chemistry in Everyday Life, by Emery Davis, Boynton, and Downey 1088
Chemistry Experiment Sheets, by Martin Mendel, *et al.* 621
Chemistry for Secondary Schools, by E. L. Dinsmore 514
Chemistry for Boys and Girls, by C. C. Greer, *et al.* 425
Chemistry in Industry, Vol. I, by H. E. Howe 225
"Chemical Age" Chemical Dictionary: Chemical Terms, The, by D. Van Nostrand Co. 158
Colloid Chemistry, Jerome Alexander 95
Diagnostic Study of the Subject-Matter of High-School Chemistry, A, by S. R. Powers 224
Distillation in Practice, by C. Elliott 1210
Early Steps in Science, by Webb and Didcoct 818
Effects of Ions in Colloidal Systems, The, by Leonor Michaelis 1210
Elements of Qualitative Analysis, The, by W. A. Noyes 621
Exercises in General Chemistry, by Horace G. Deming 226
Foundations of Colloid Chemistry, The, by Emil Hatschek 1210
General Chemistry, by Horace G. Deming. 226
General Chemistry, by H. I. Schlesinger .. 949
Grundzüge der Kolloidlehre, by Herbert Freundlich 157
Handbook to the Exhibition of Pure Science Arranged by the Royal Society 515
High-School Chemistry, by Chas. E. Dull. 721
How to Teach General Science, Notes and Suggestions of Practical Aid to Every Science Teacher, by J. O. Frank 1089
Humanizing of Knowledge, The, by James Harvey Robinson 223
Inorganic Physical Chemistry, by H. Cartledge 223
Intermediate Chemistry Companion, by Jas. Kendall 720
Introduction to the Practice of Organic Chemistry in the Laboratory, An, by S. M. McElvain and Homer Adkins .. 719
Introduction to Theoretical Physics. Vol. I, by Arthur Haas 719
Introduction to Organic Research, by E. Emmet Reid 158
Junior Science, by J. C. Hessler 622
Laboratory Course in Chemistry, A, by Guy Clinton, *et al.* 424
Laboratory Manual of Chemistry, by George Howard Bruce 59
Laboratory Studies in Chemistry, by R. H. Bradbury 719
Lecture and Laboratory Experiments in Physical Chemistry, by Henry S. van Klooster 1089
Modern Inorganic Chemistry, by J. W. Mellor 949
Non-Metallic Minerals, Occurrence—Preparation—Utilization, by Raymond B. Ladoo 819
Physical Chemistry, by Jas. C. Philip 818
Physical Chemistry for Students of Medicine, by A. Findlay 424
Pronouncing Chemical Formula Speller and Contest Guide, A, by C. A. Jacobson 721
Quantitative Analysis, by Jas. M. Hendel. 1089
Report of the Division of Chemistry and Sanitation of the N. H. State Board of Health, by Chas. D. Howard 515
Rich's Chemistry Tests, by S. G. Rich. 622
Science of Everyday Life, The, by E. F. Van Buskirk, *et al.* 515
School Chemistry, A, by O. J. Flecker. 624
Story of Early Chemistry, The, by John Maxson Stillman 95
Teaching Science in the Schools, by Elliot R. Downing 1090
Teaching of Science and the Science Teacher, The, by Herbert Brownell and Frank B. Wade 1211
Test of High-School Chemistry, A, by H. L. Gerry 425